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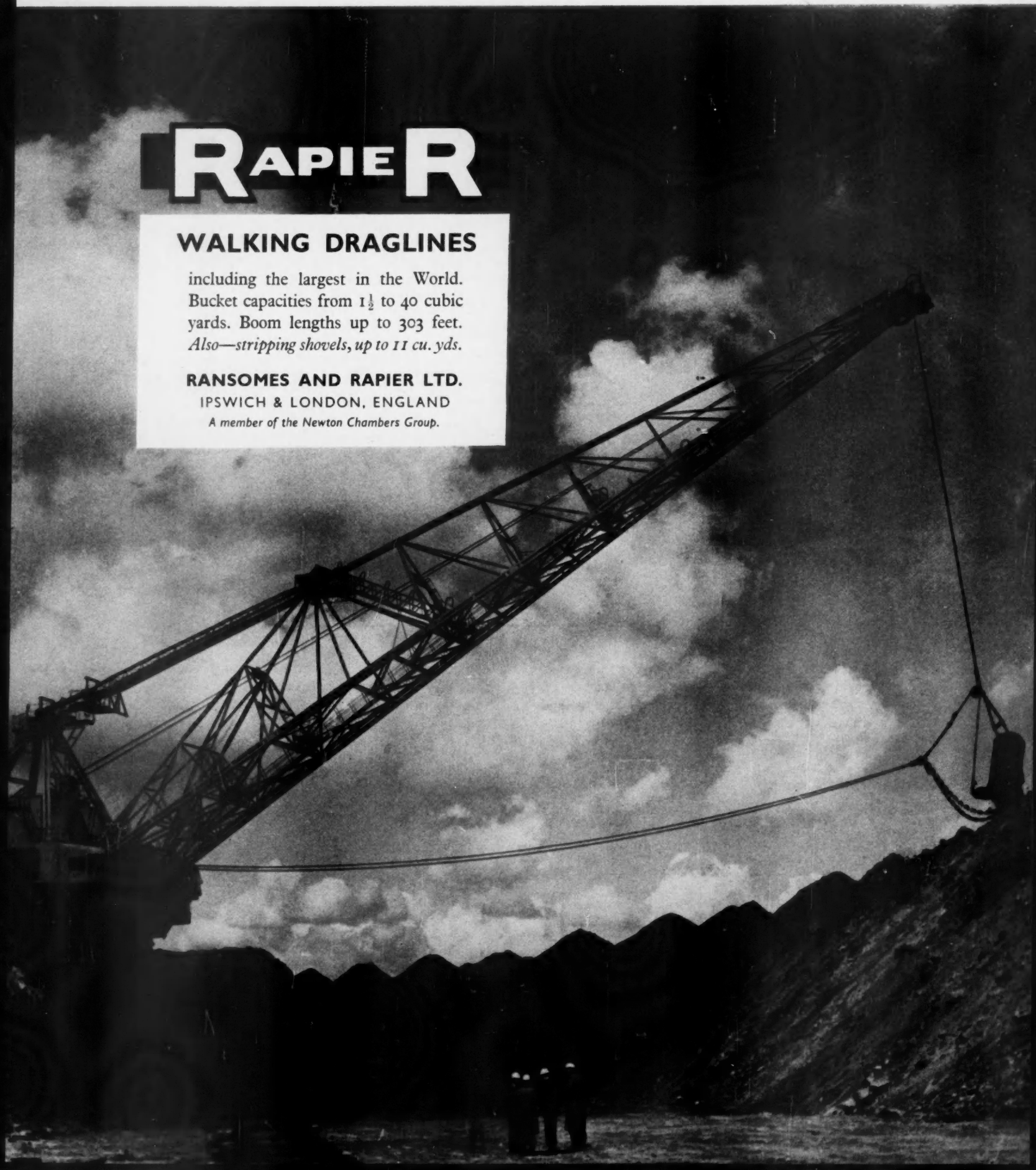

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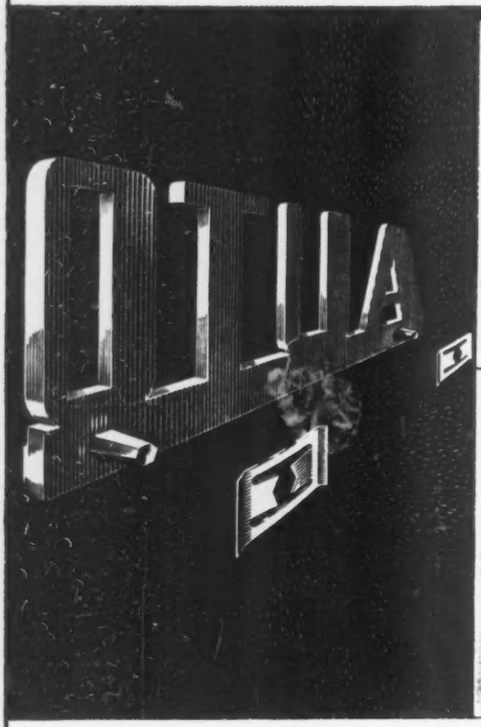

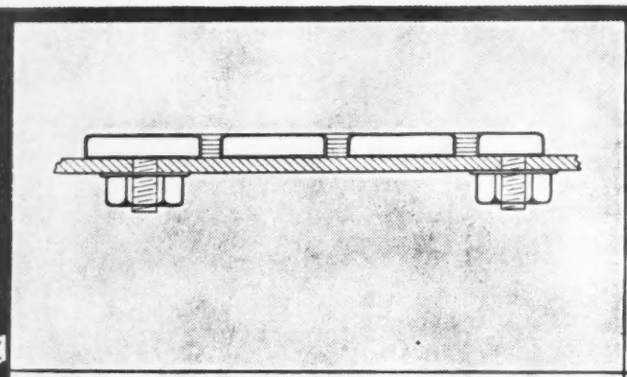

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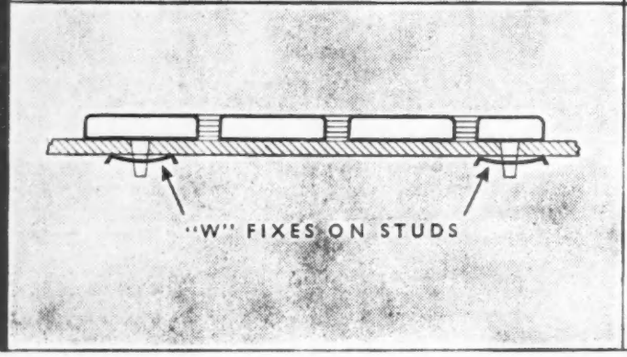

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EDITORIAL CONTENTS

Leading Articles

British Railways A.C. Electrification . . . 169
The Forthcoming T.U.C. . . . 169
A Welcome to Foreign Firms . . . 170
" Blue Streak " Dimensions. . . . 170
A London Transport Document . . . 171

Articles

100 Years Ago. . . . 171
S. Leliavsky Sixth Congress on Large Dams, New York. No. II . . . 172
Automatic Correction of Microwave Fading . . . 180
Automatic Oil Burner Control. . . . 181
Maidstone By-Pass . . . 182
A. C. Hartley Century of Oil. No. I . . . 183
Commonwealth Spaceflight Symposium . . . 188
Hugh L. Dryden Global Aspects of the Exploration of Space . . . 189
Passenger and Cargo Ship for Lake Victoria . . . 191
Murton Coking Plant . . . 192
Mobile Demonstration Unit for Electronic Control Equipment . . . 196
London Motorway Proposal . . . 196
Anglo-American Moon Echo Experiment . . . 196
Portable Sludge Pump . . . 196
Transistorised Control Relay . . . 196
Television Lighting for Reactor Charge Machine . . . 197
Strategic Transport Aircraft . . . 197
Institute of Metals Visit to Sweden and Denmark . . . 197
Centrifugal Clutches . . . 197
Bilge Block Assemblies for a Dry Dock . . . 198
Magnet Coils for 7 GeV Proton Synchrotron . . . 198

Continental Section

Tubular Turbines . . . 200
Holland-America Liner S.S. " Rotterdam " . . . 202
Swiss Nuclear Station. . . . 202

American Section

Nuclear-Powered Passenger-Cargo Ship " Savannah. " No. I. . . . 203

LETTER Costs of Bridges and Electrification . . . 186

BOOK REVIEWS . . . 186

NEWS AND NOTES Industrial and Labour Notes . . . 199
Personal and Business . . . 206
Launches and Trial Trips . . . 207
Forthcoming Engagements . . . 207
British Patent Specifications . . . 208

INDEX TO ADVERTISERS : PAGE 153 **CLASSIFIED ADVERTISEMENTS : PAGE 145**

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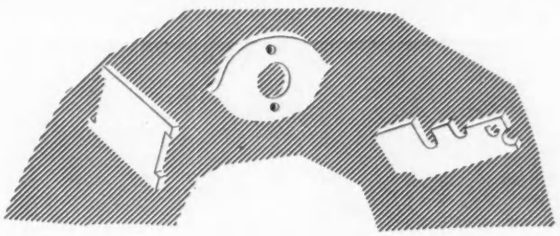

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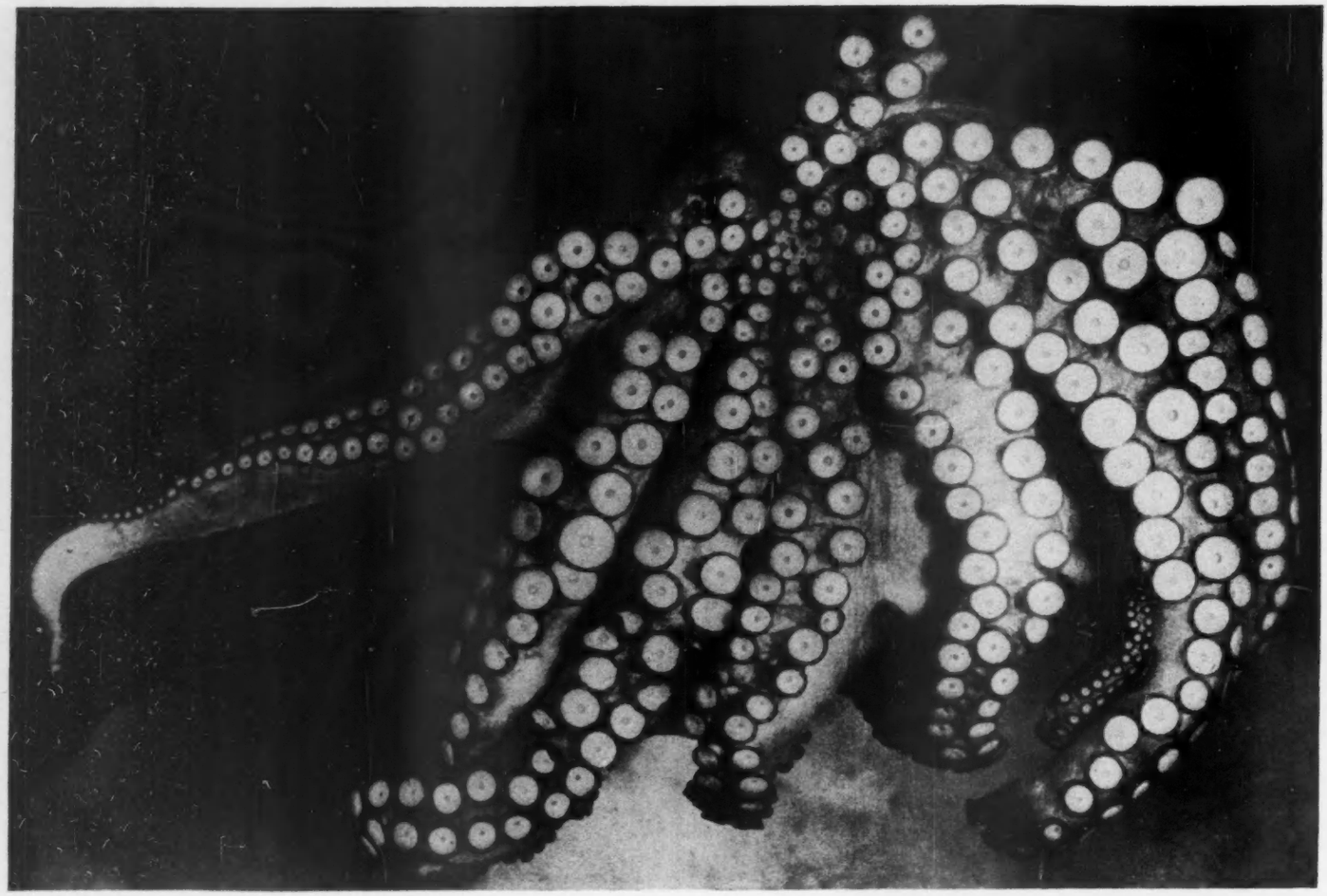

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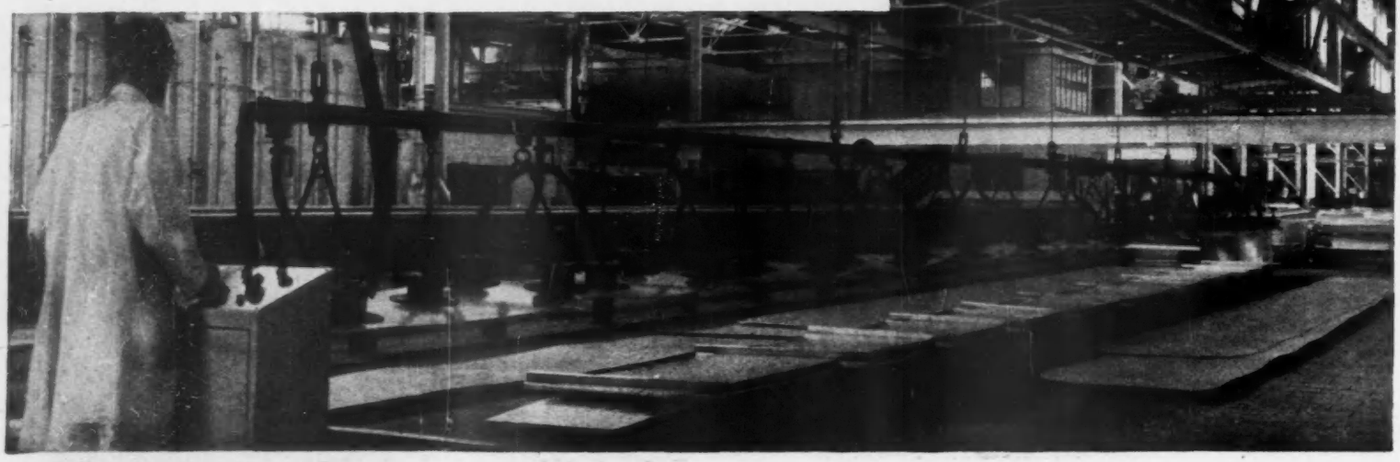

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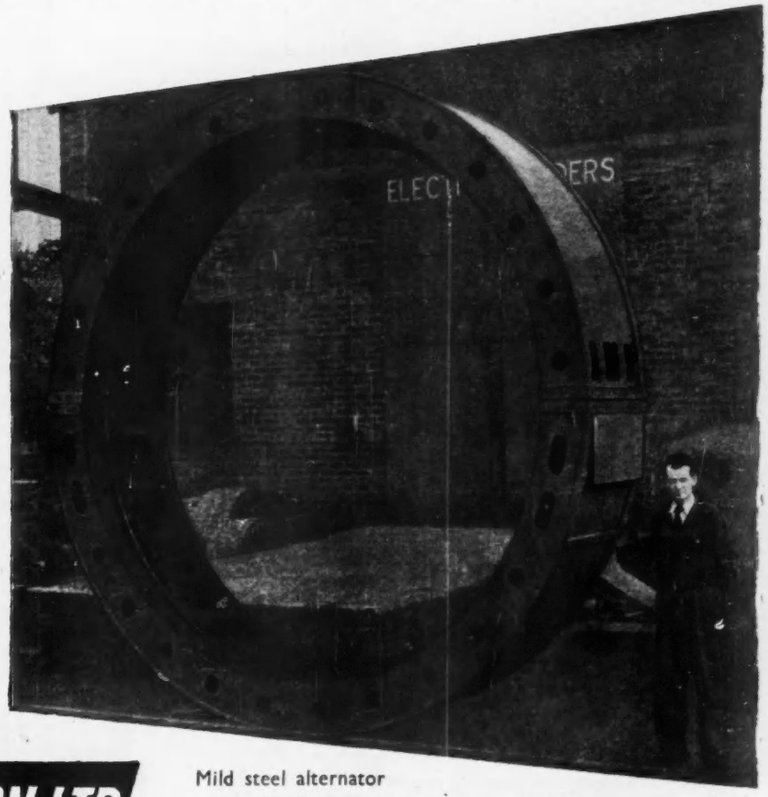

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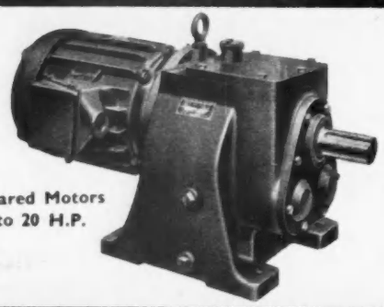

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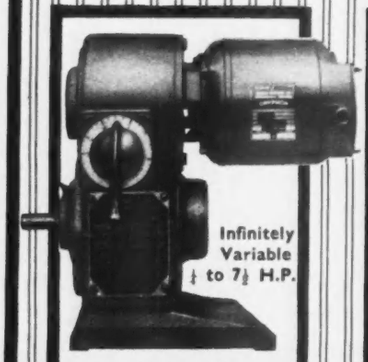

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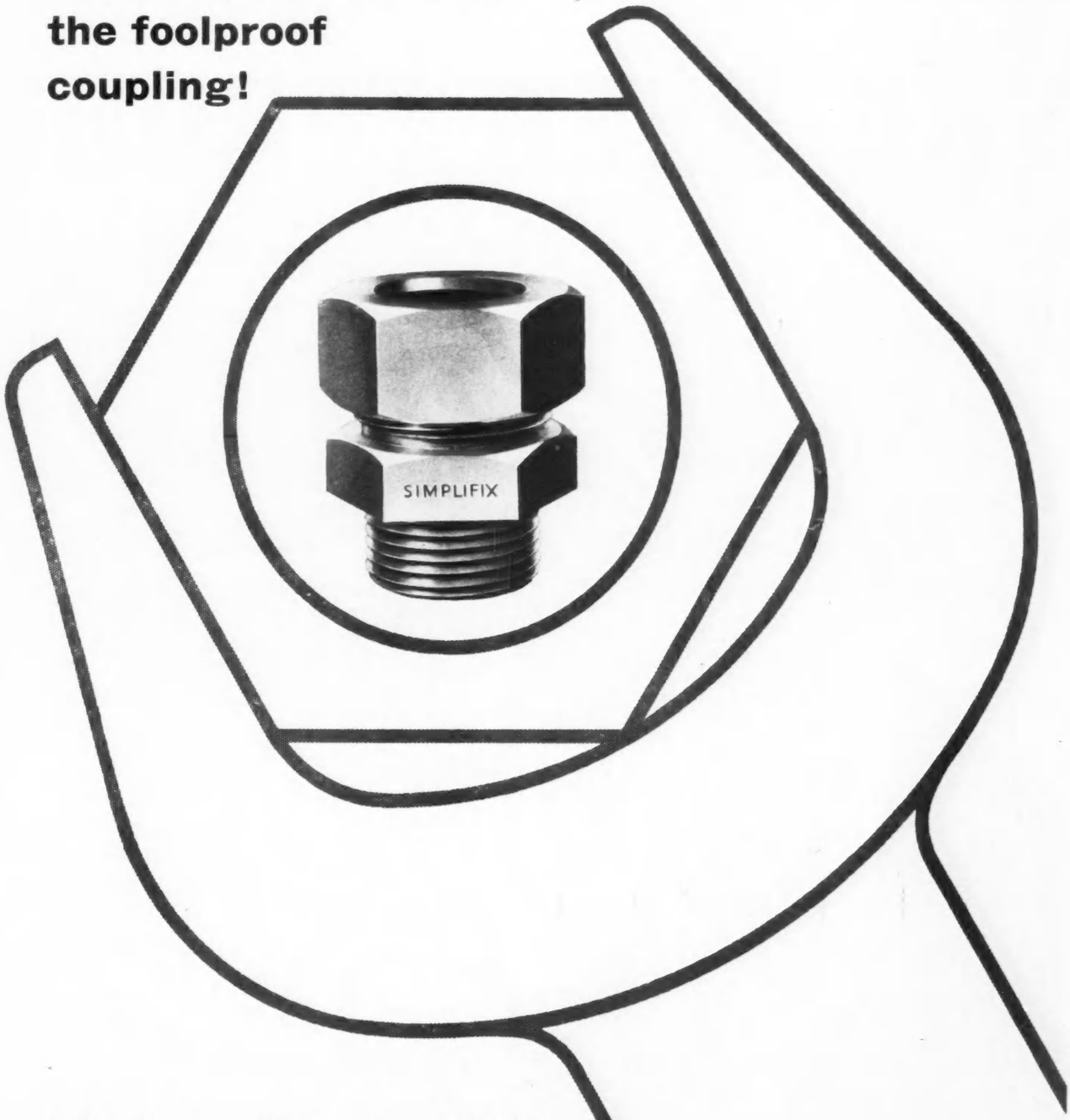

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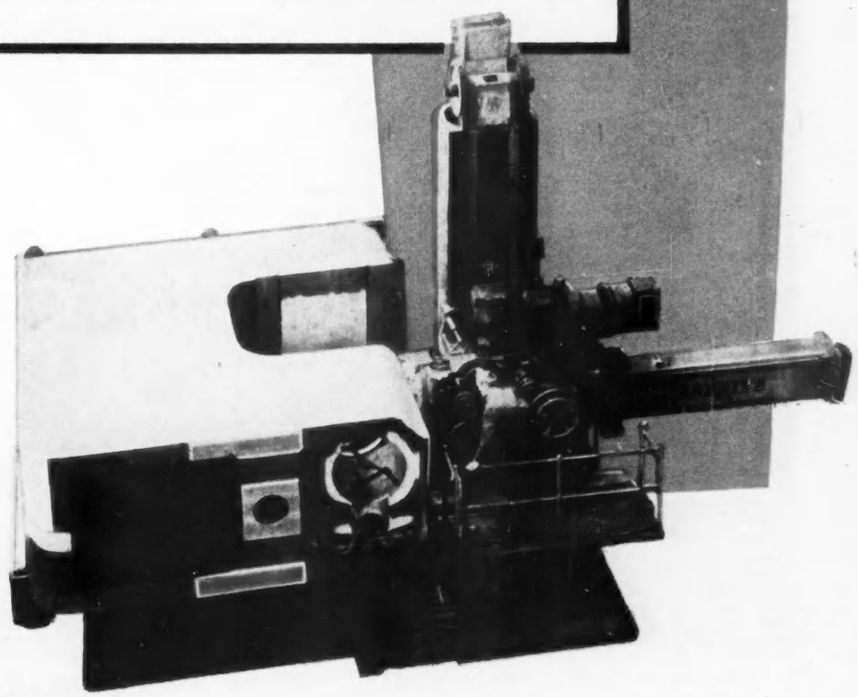

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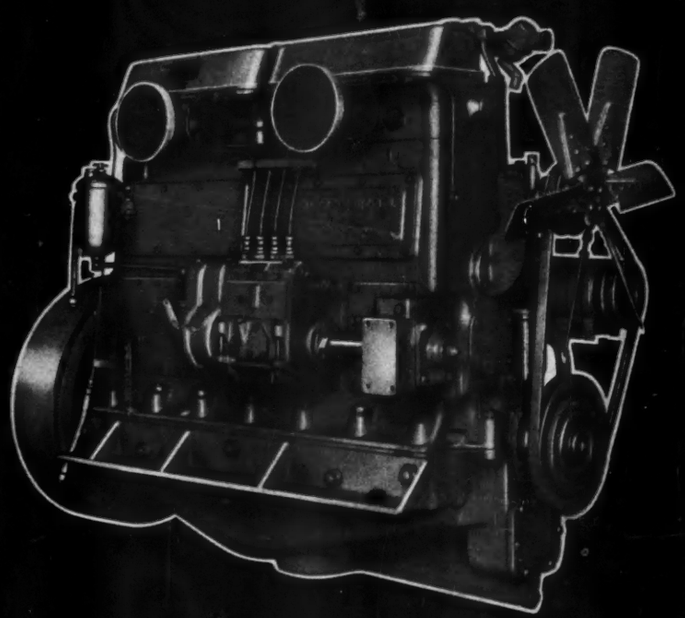

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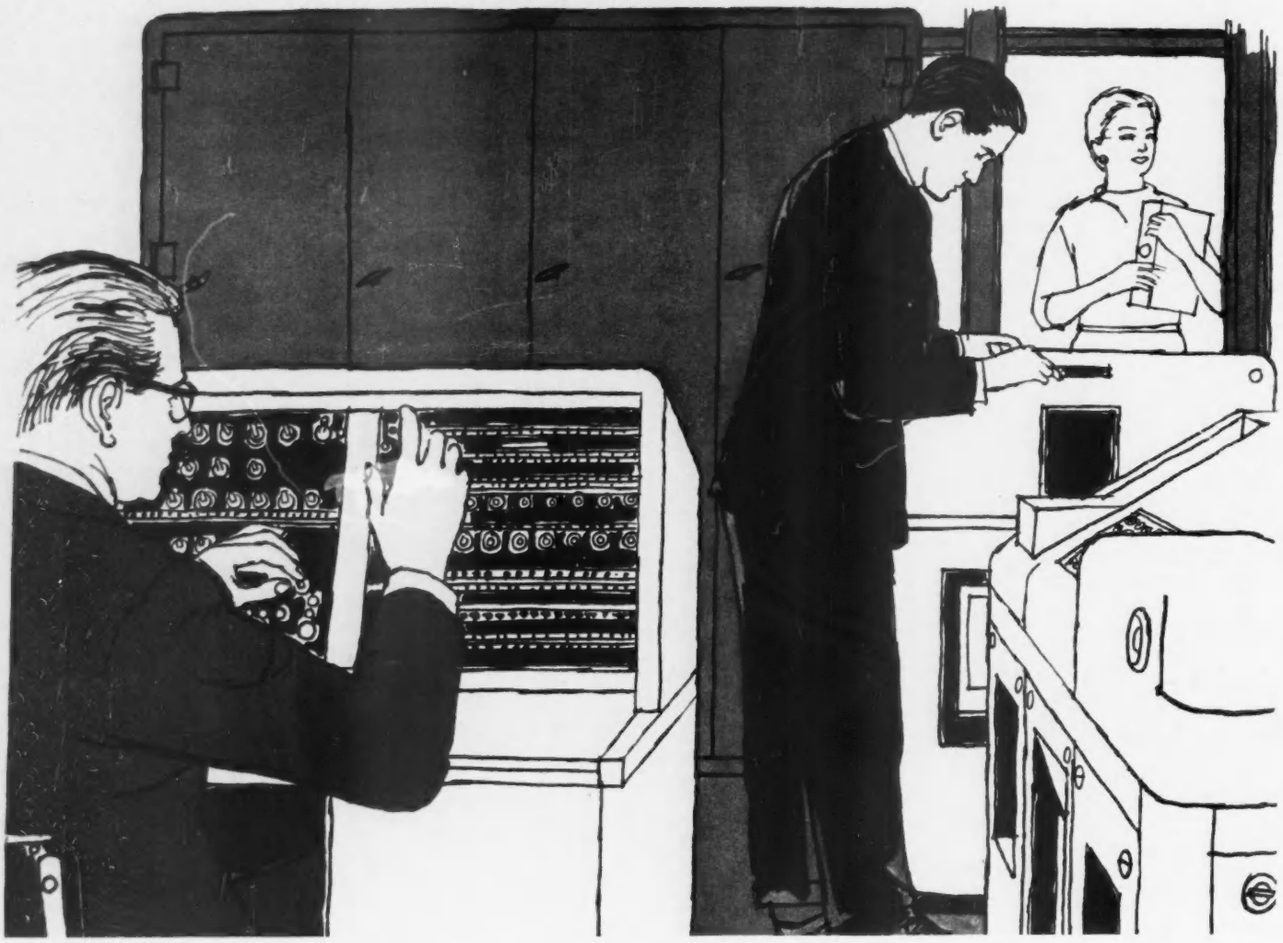

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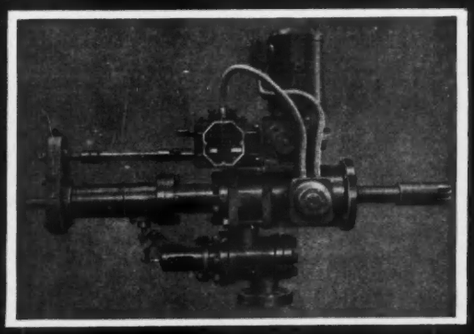
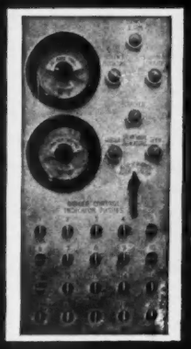


THE BLOWER: The complete operating cycle is in one motion and is driven through a compact mechanism by a non-reversing motor. When the operating shaft is rotated, the nozzle advances, the steam ports open and, at the same time, rocking motion is automatically transmitted to the nozzle. The uni-directional motor eliminates the bulky contactor gear used with reversing motors and reduces electrical maintenance by being of simpler and more rugged construction.

The reversing motion is achieved *mechanically* on all Lectramek blowers. A limit switch mounted on the gear box and connected to the starter regulates the stopping, starting and number of strokes.



AND THE CONTROL PANEL
Simple controls to operate the automatic sequence are grouped on this small unit which takes up little space on the main boiler control panel.

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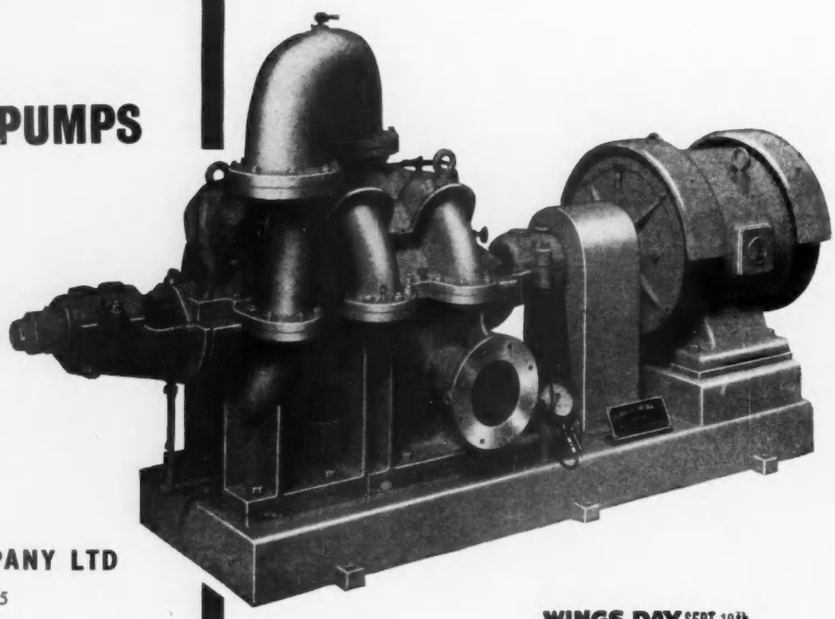

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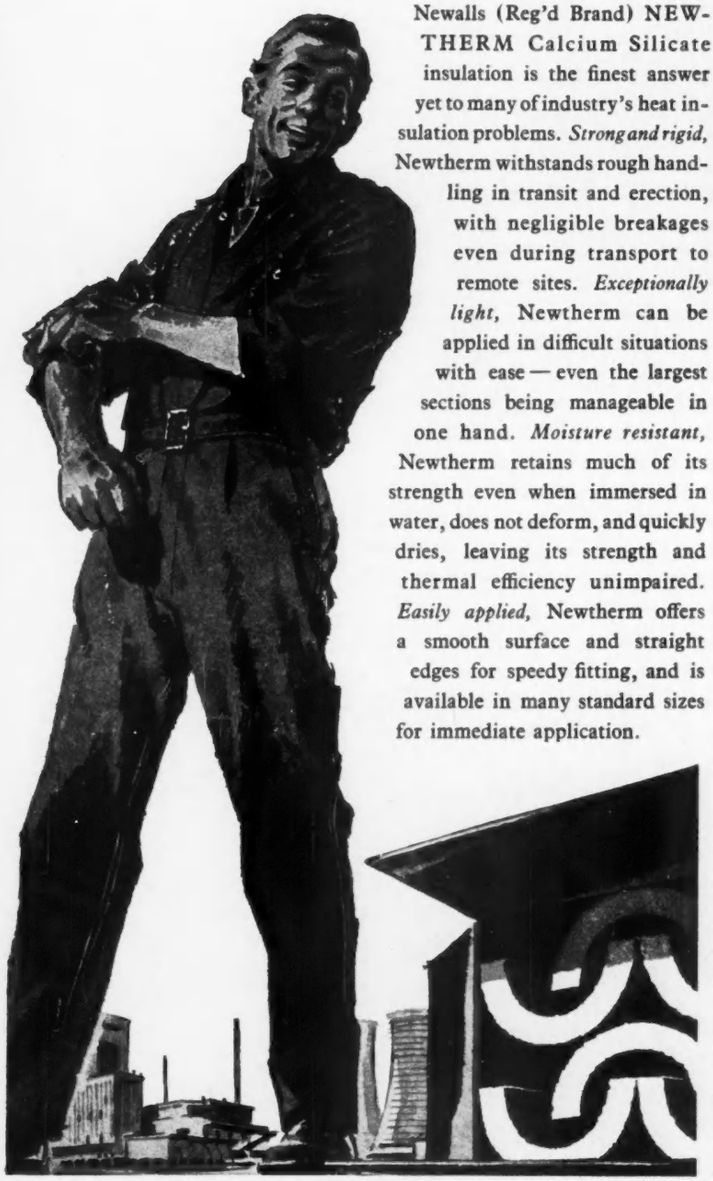

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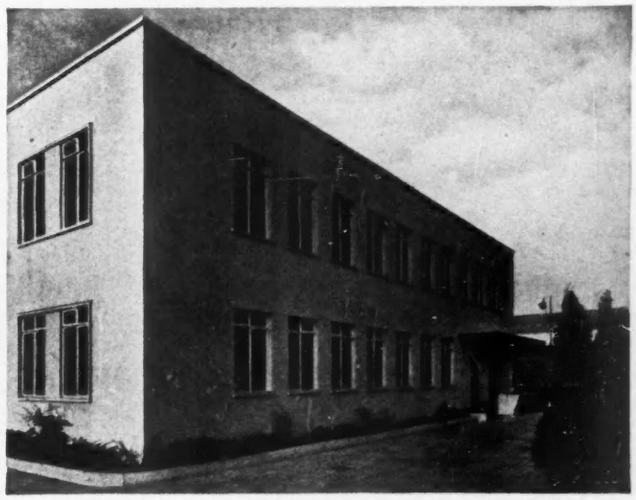

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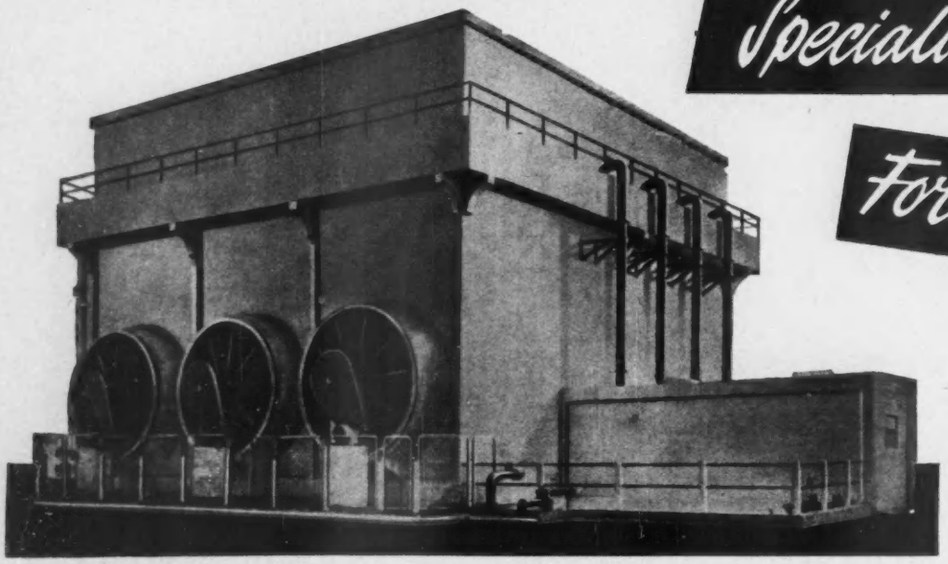

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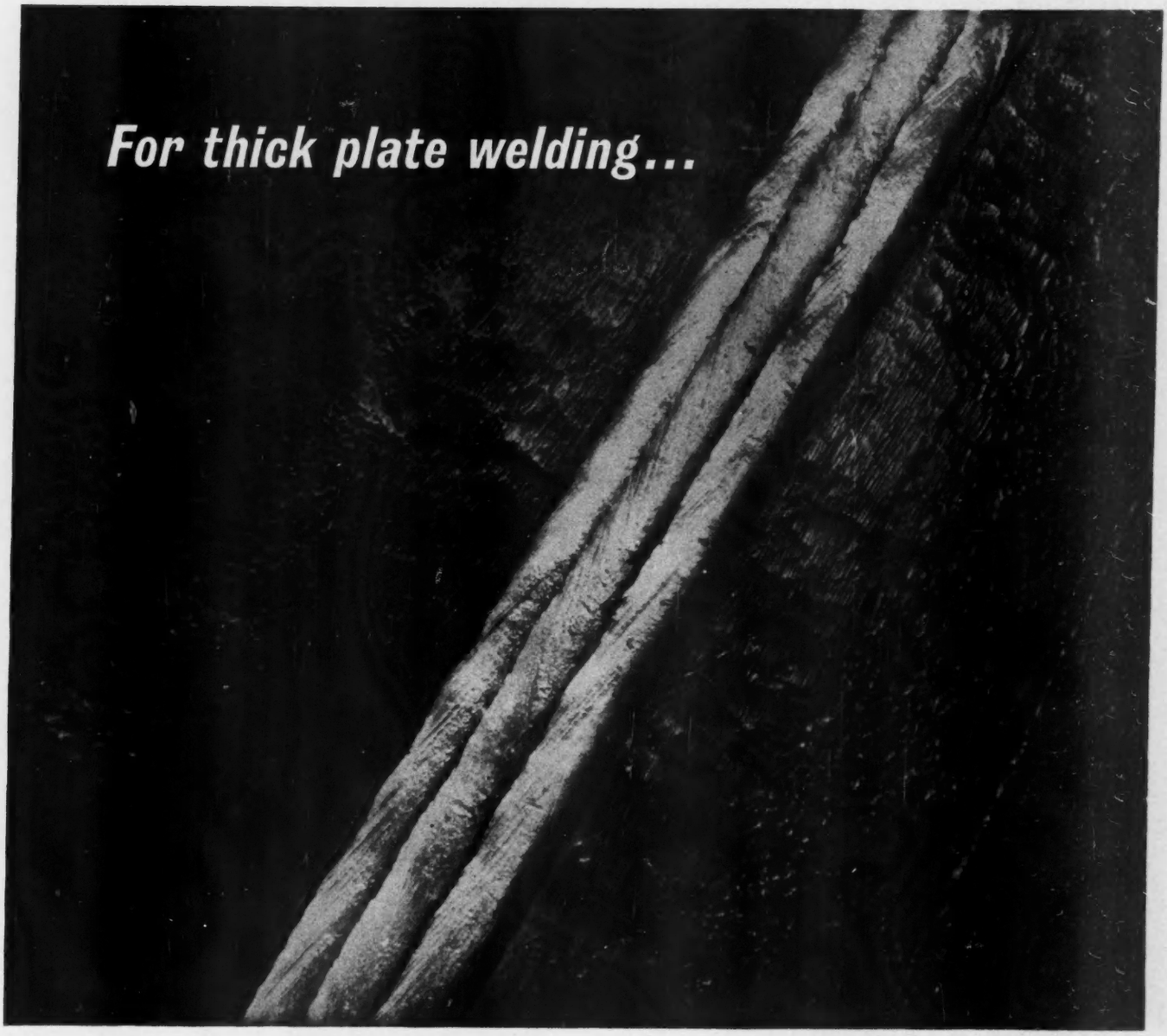
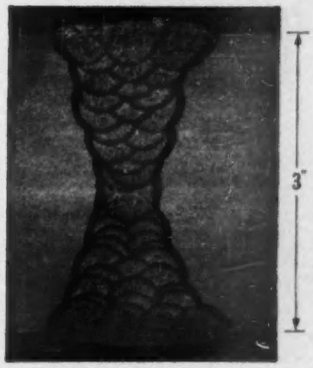


Murex "Muraflux A" submerged-arc welding flux



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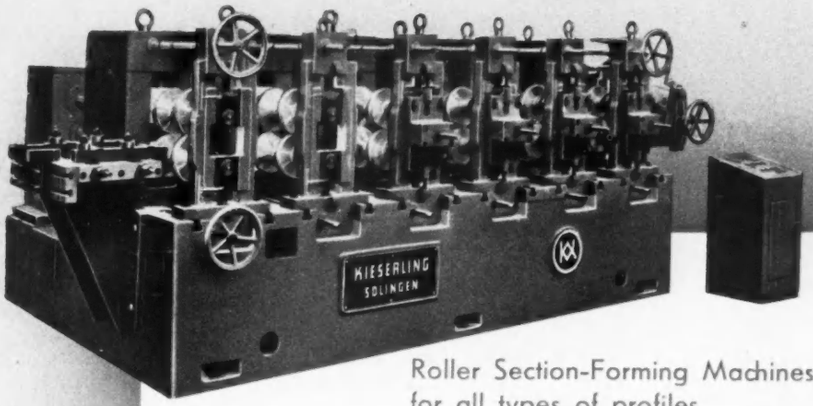

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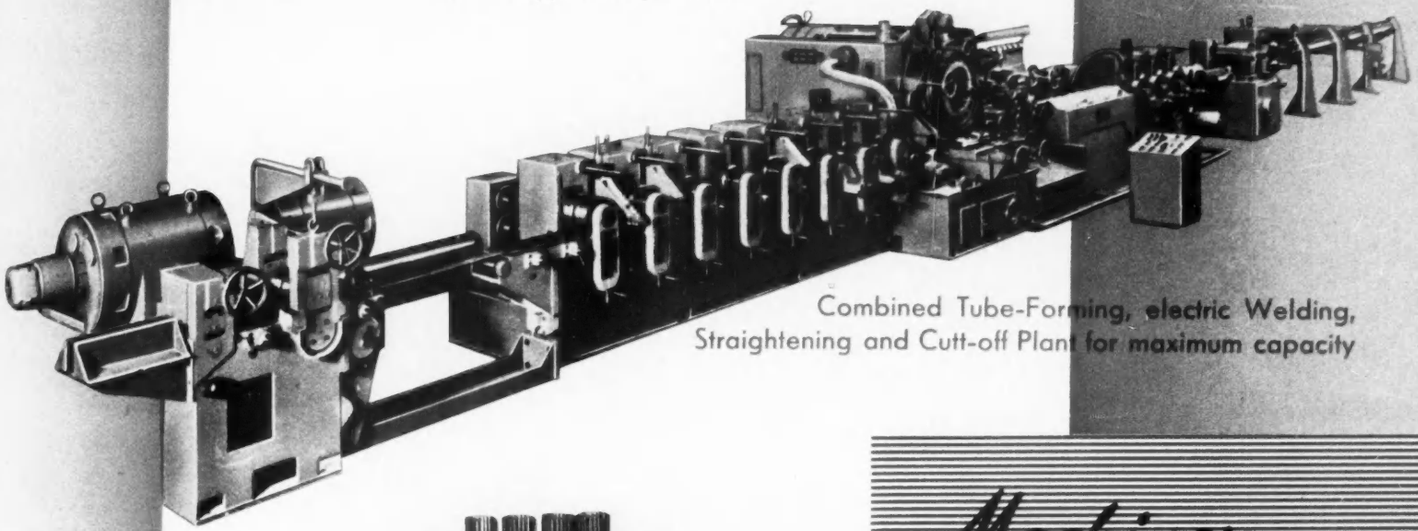

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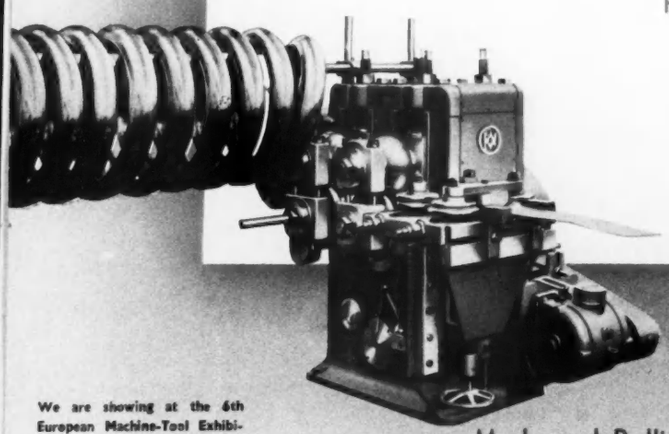

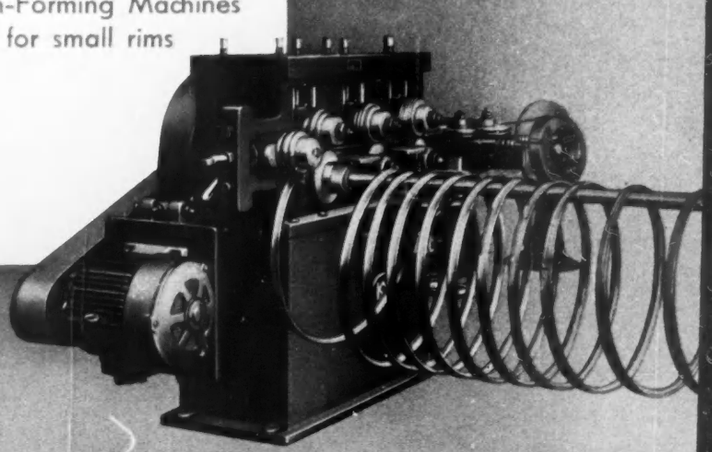

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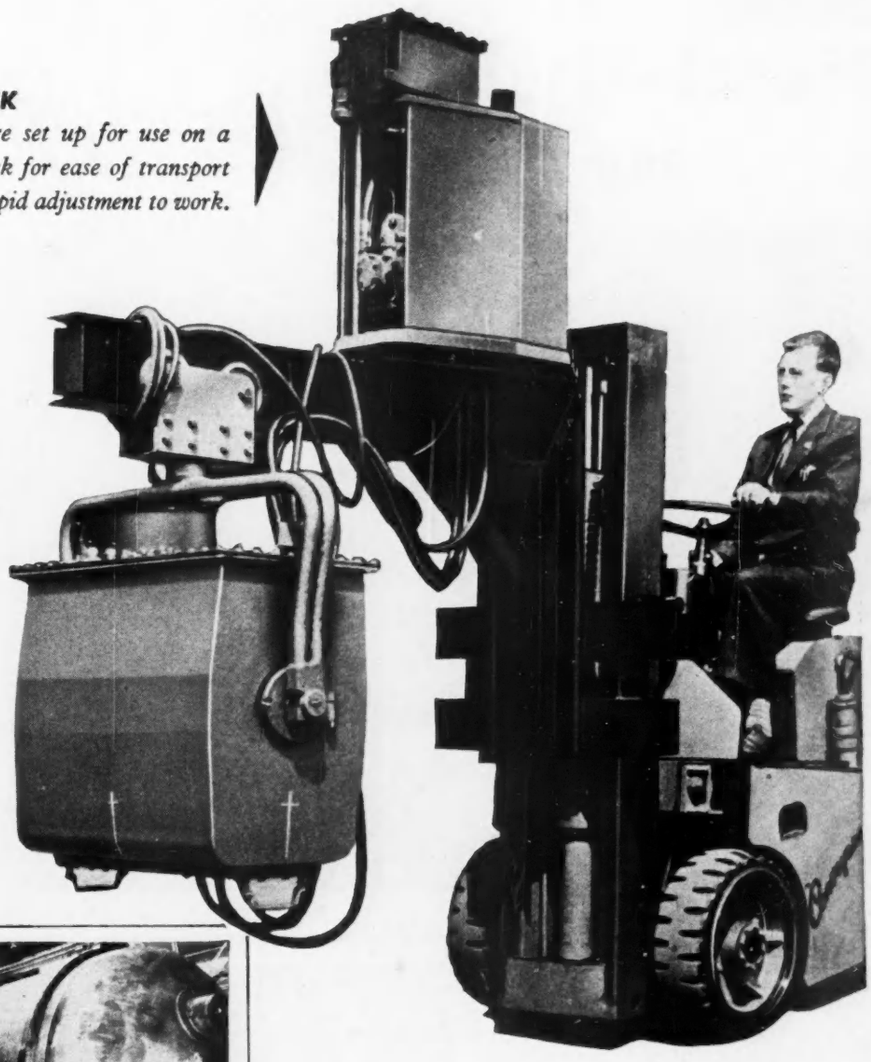

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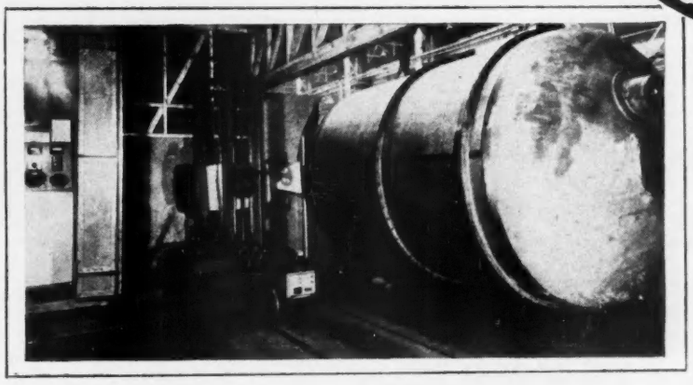

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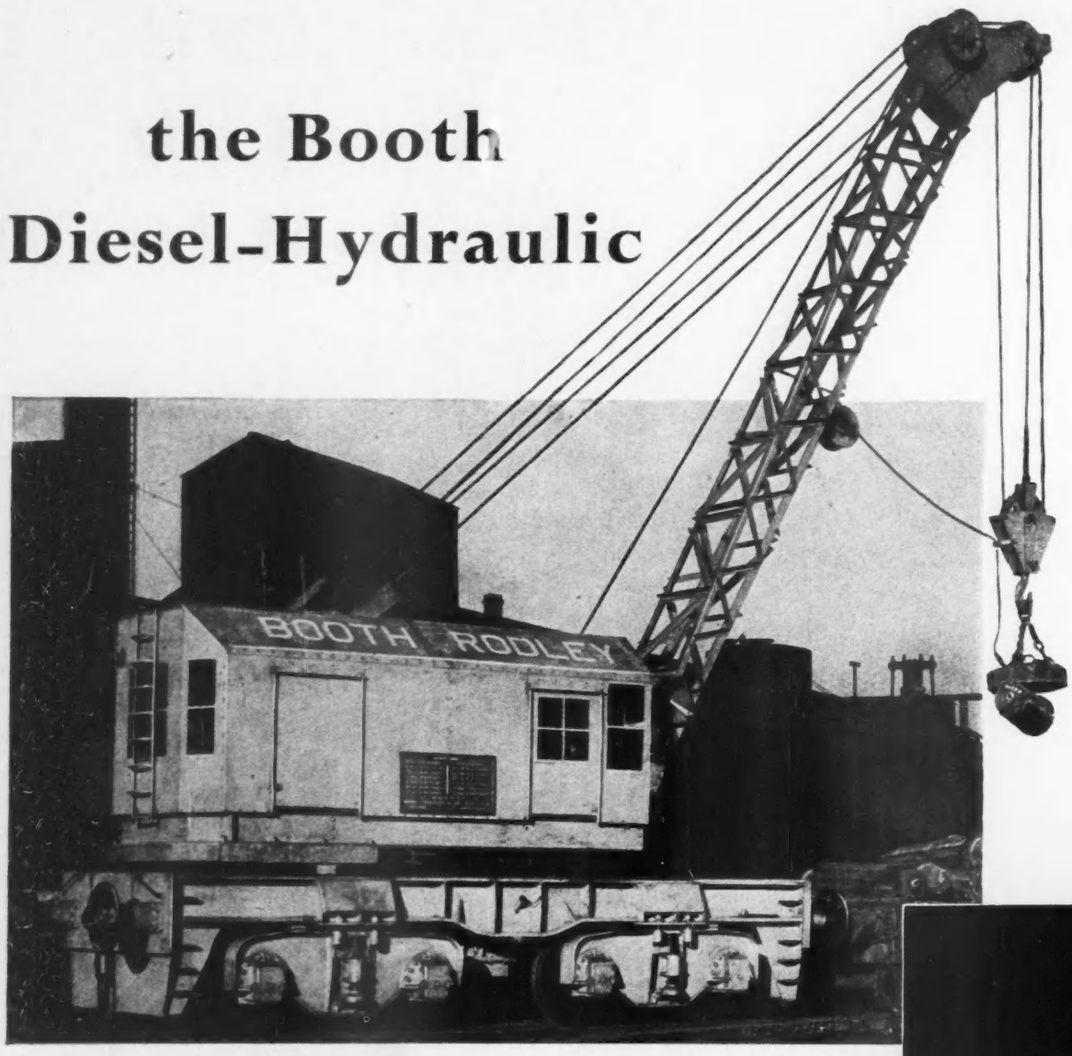

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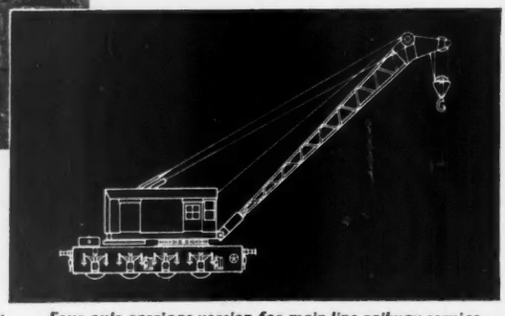

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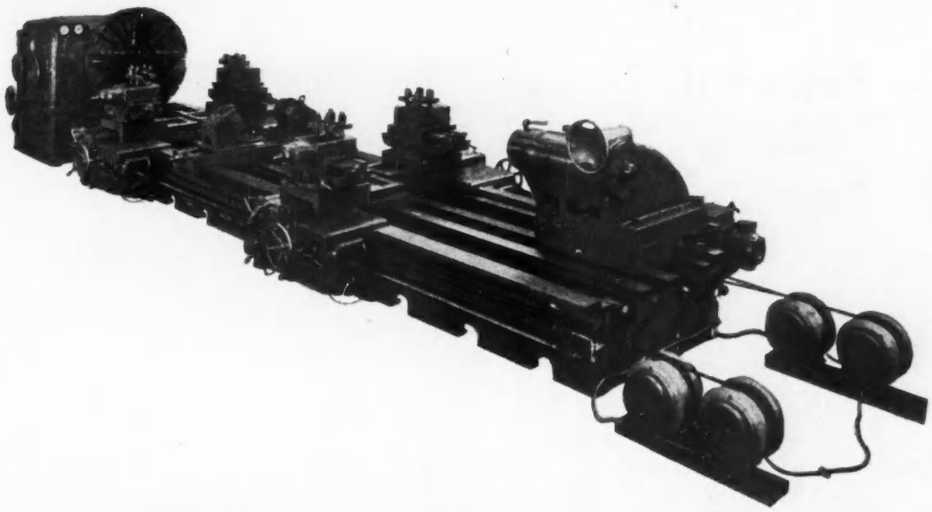

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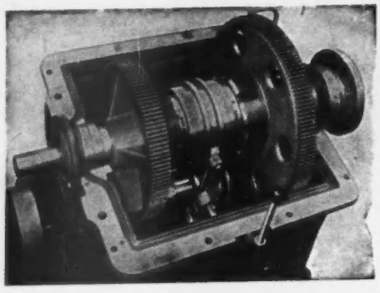

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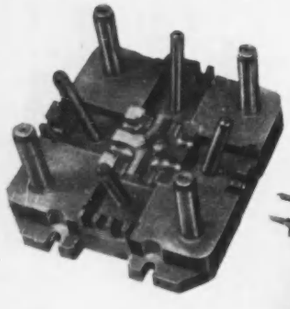

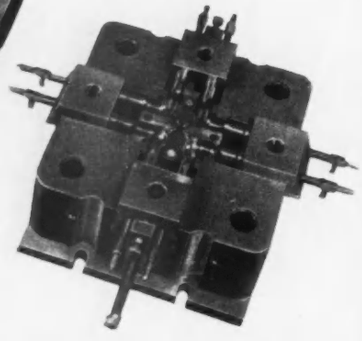

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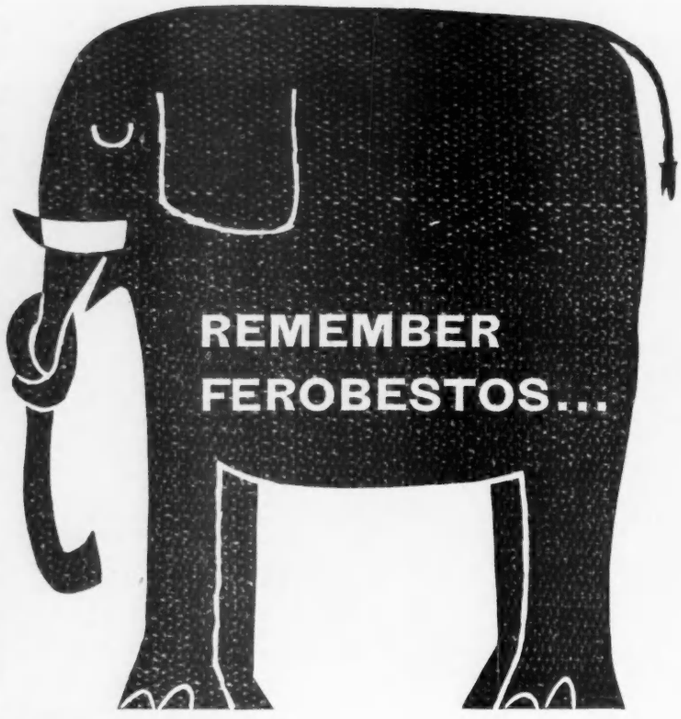

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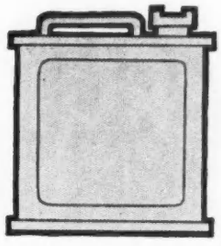

From a can of

PETROL

to a tanker of

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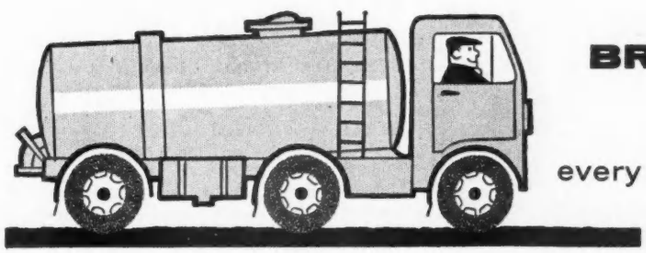

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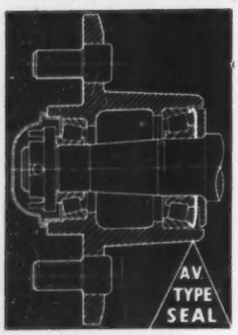

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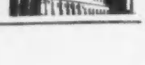

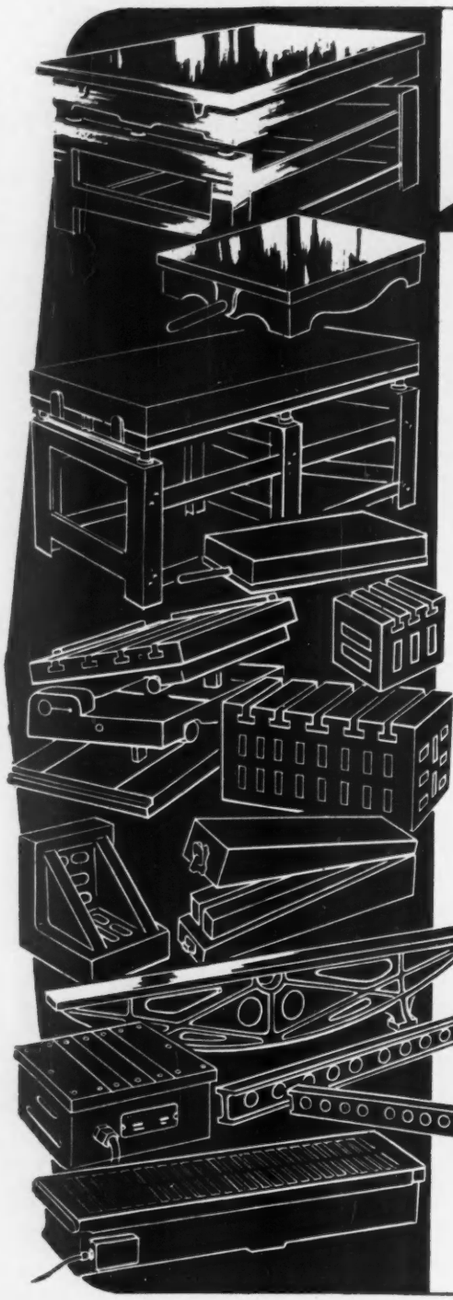

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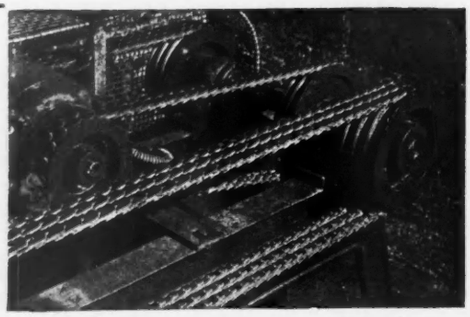

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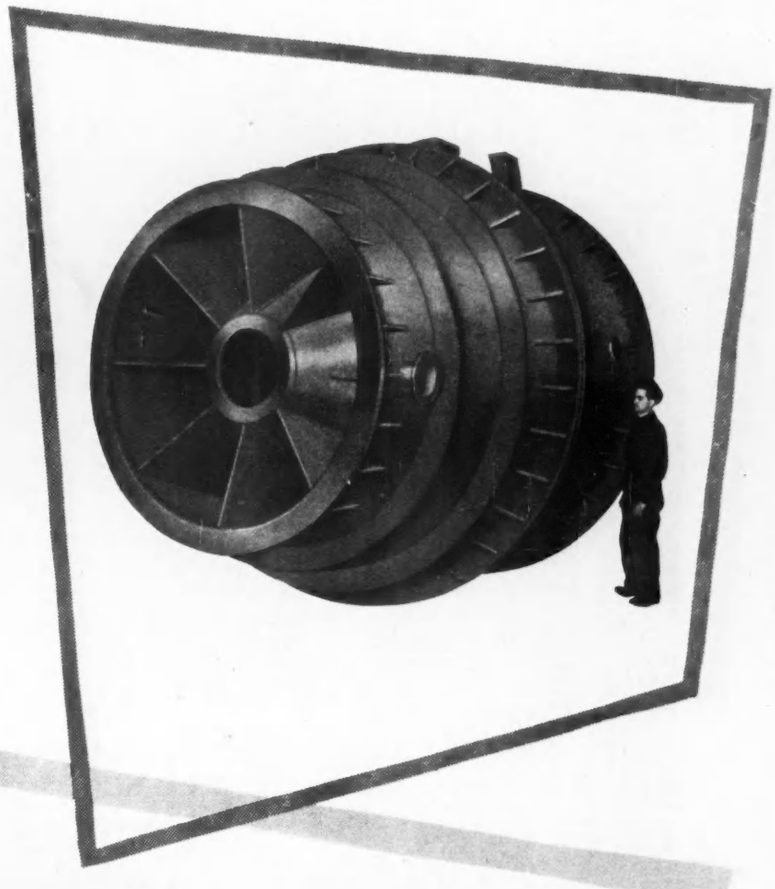
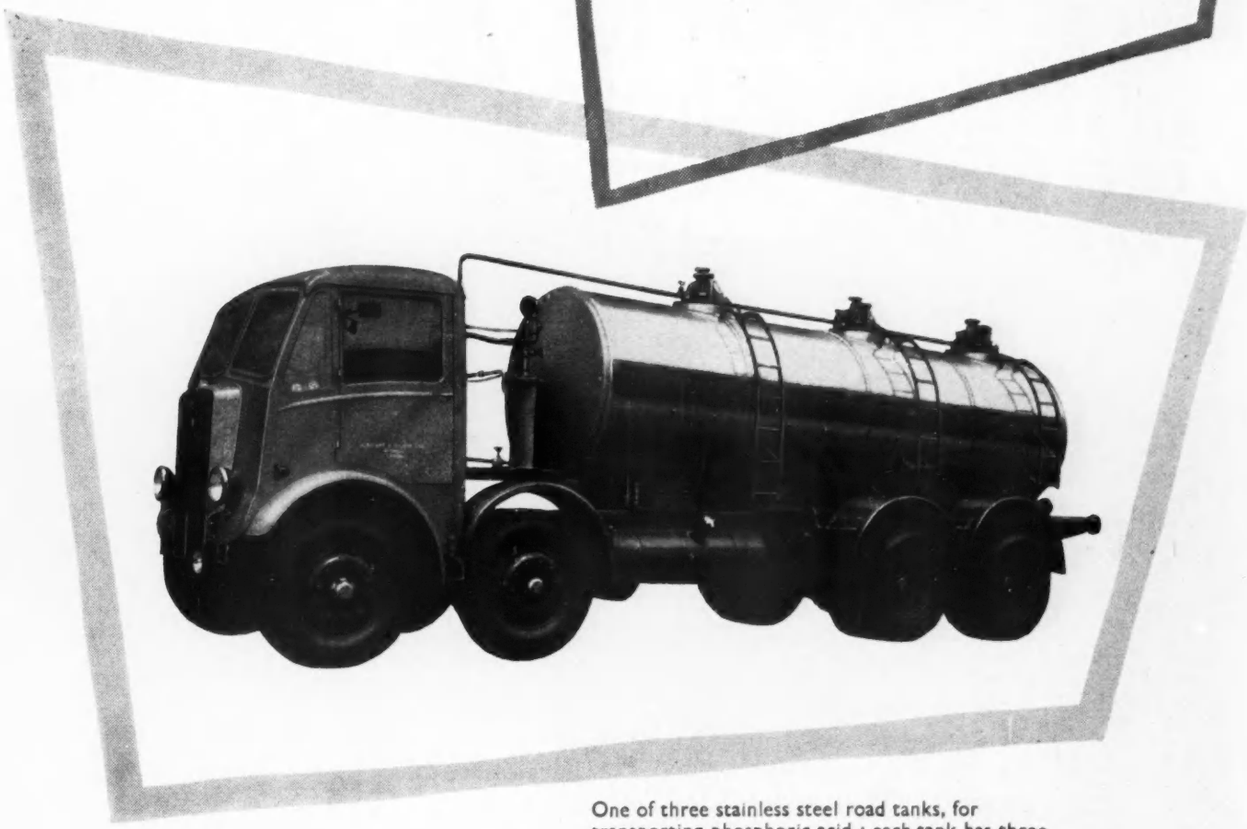


⅜" mild steel plate valve casing, weighing 4 tons; in two pieces, a cylinder and a cone; dia. 9′ 7″ tapering to 6′ 2″ by 10′ 4¼″ long.



One of three stainless steel road tanks, for transporting phosphoric acid ; each tank has three compartments and is jacketted with aluminium.

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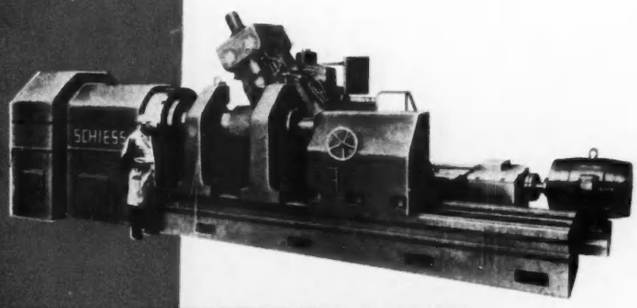

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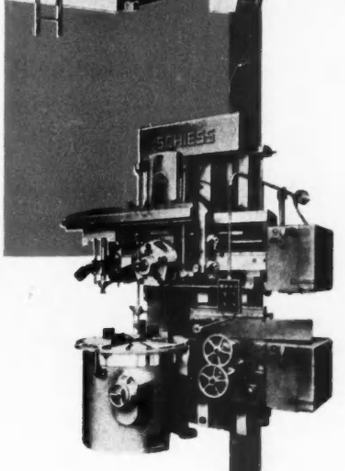

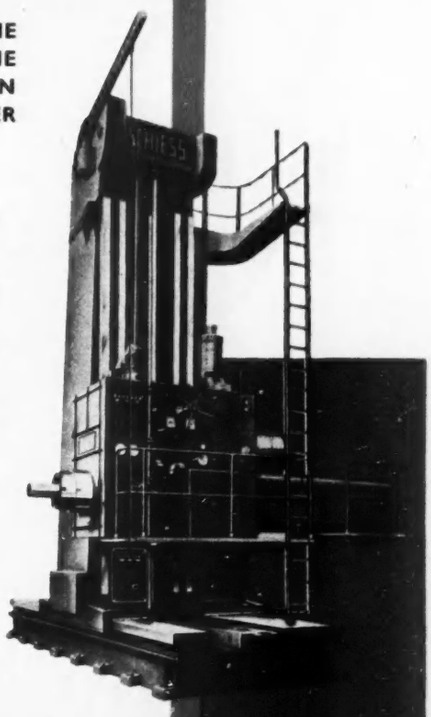

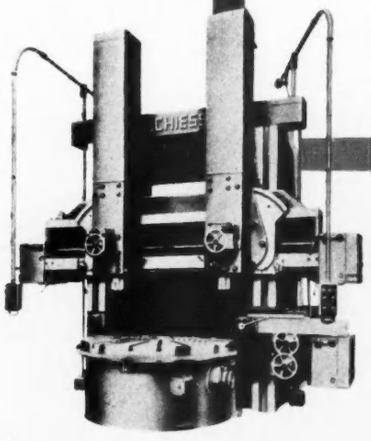

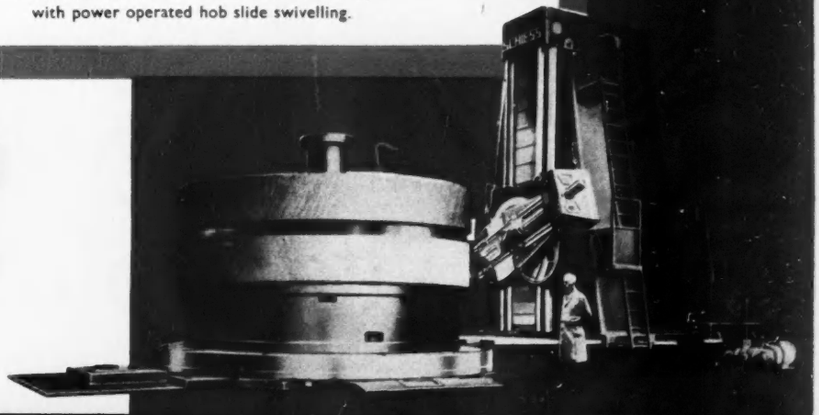

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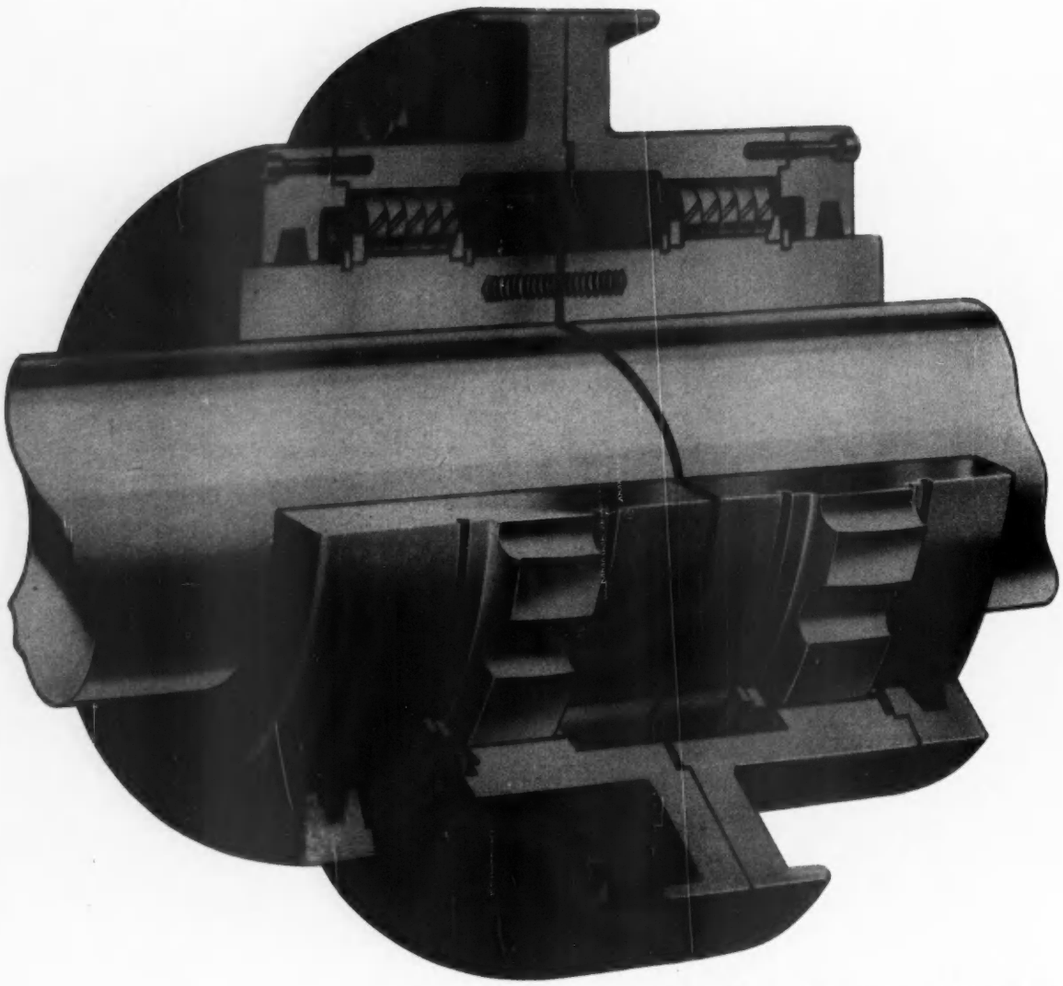

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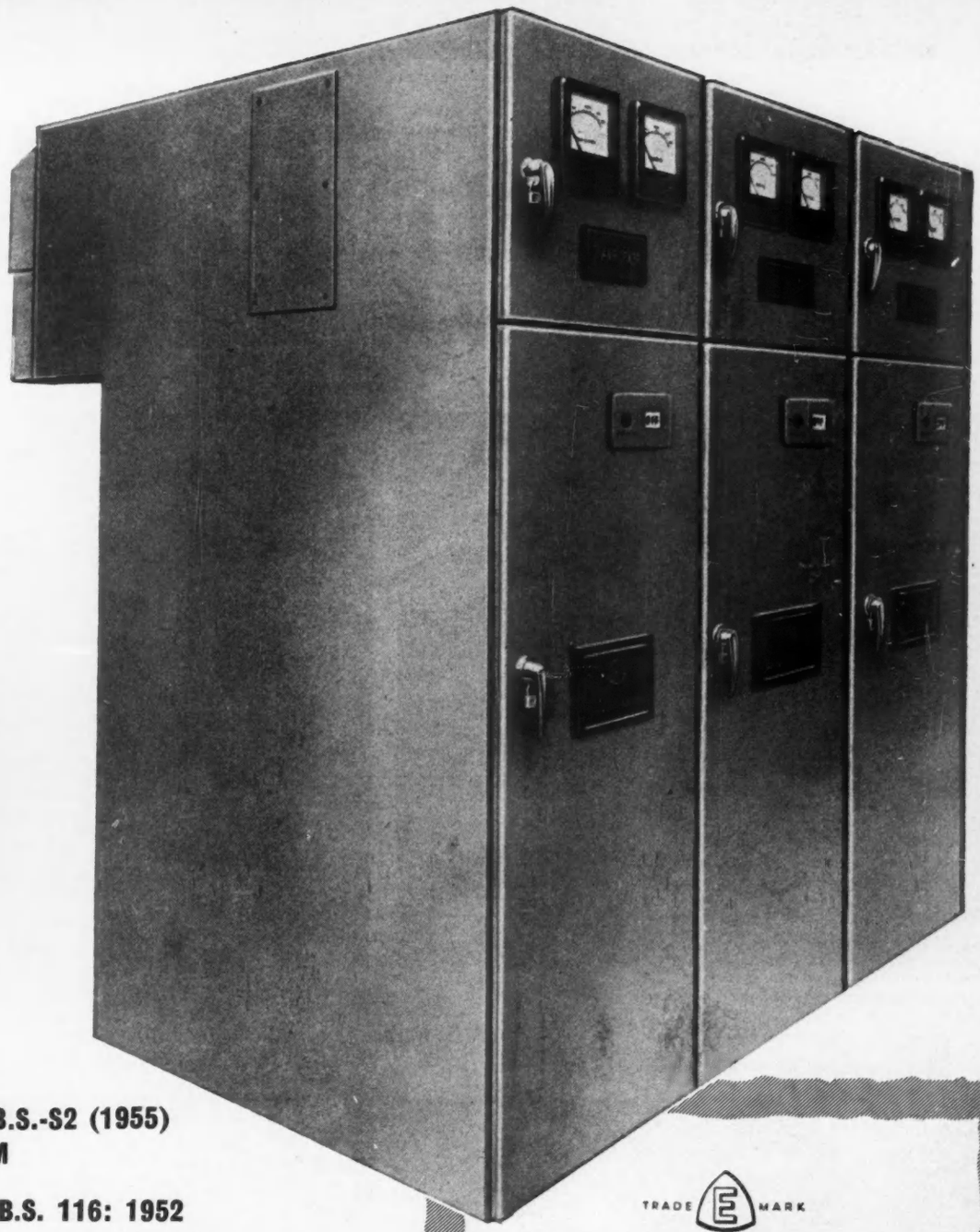

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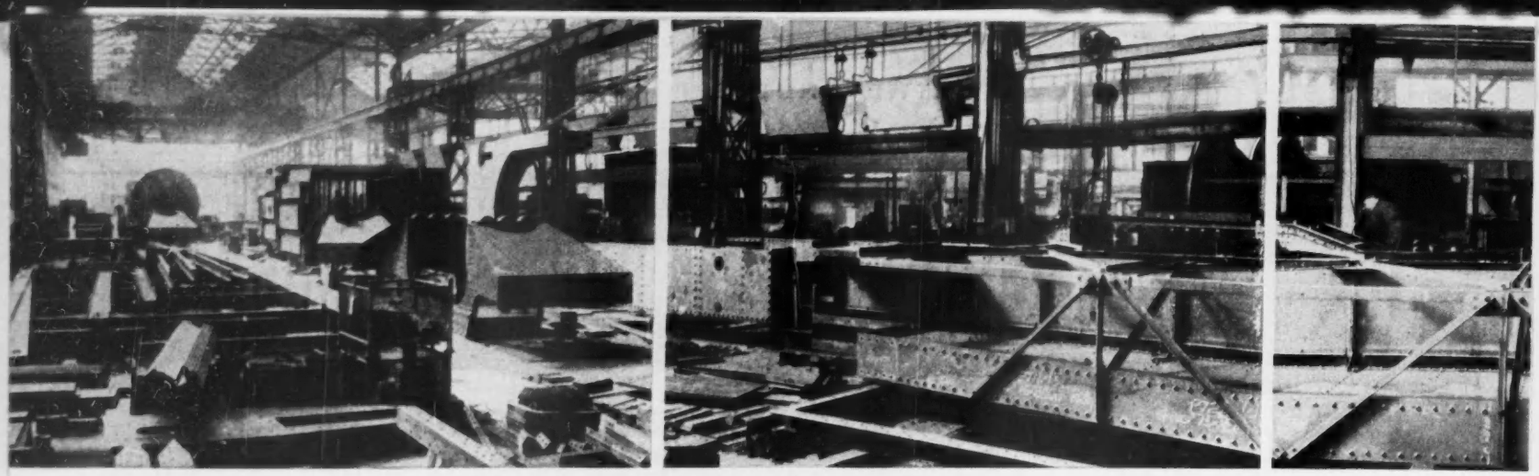

Panoramic view of the extended constructional shops

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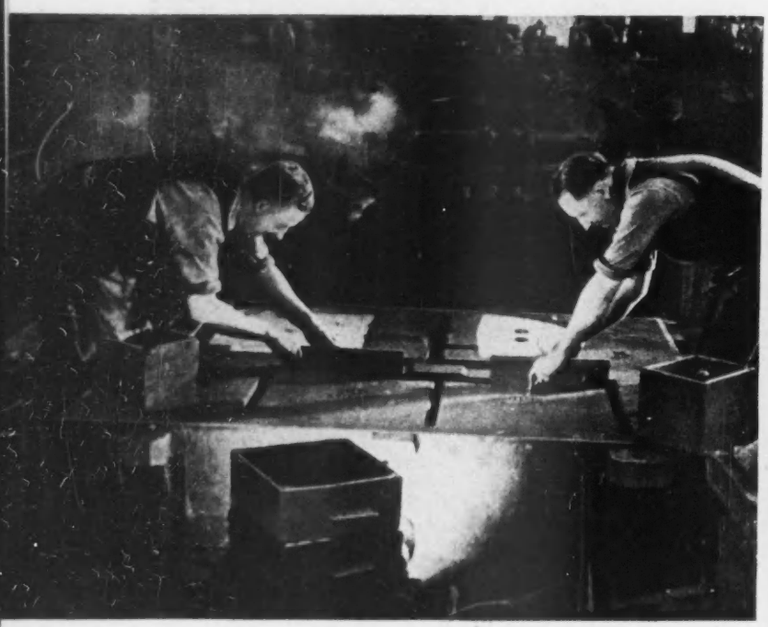
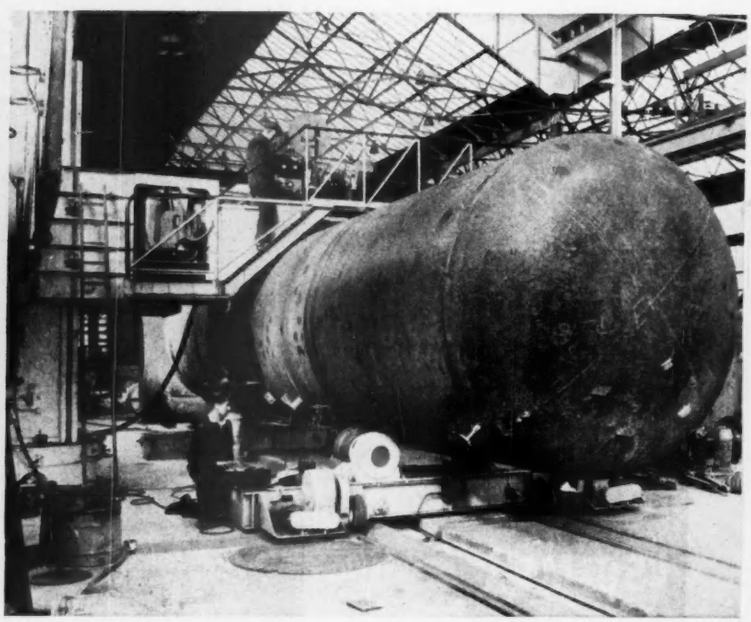


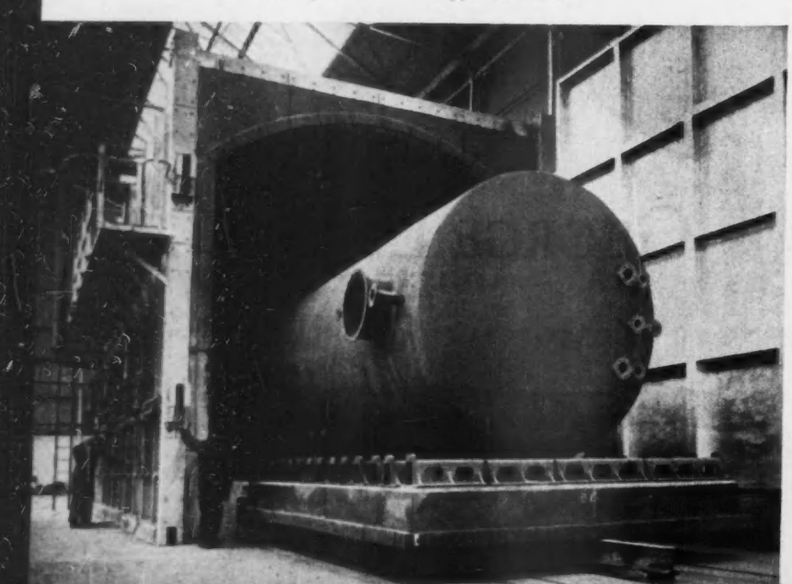
Preparing to cast in Meehanite metal in the foundries.

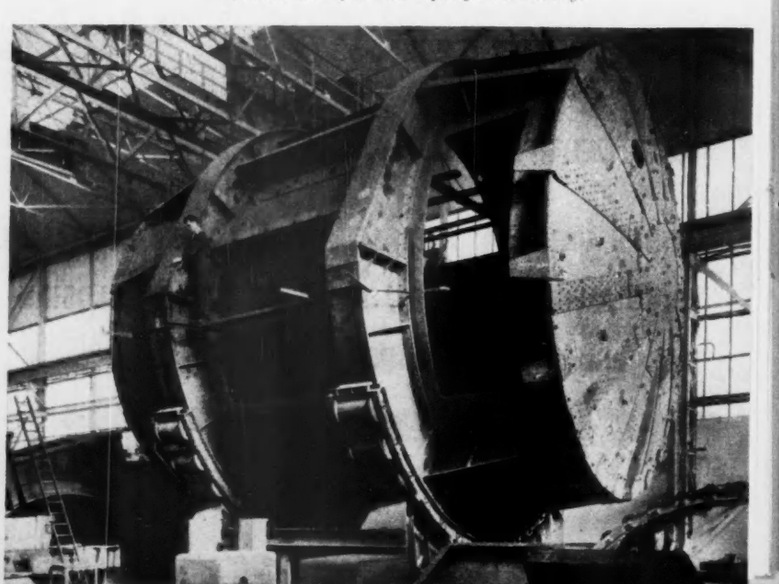


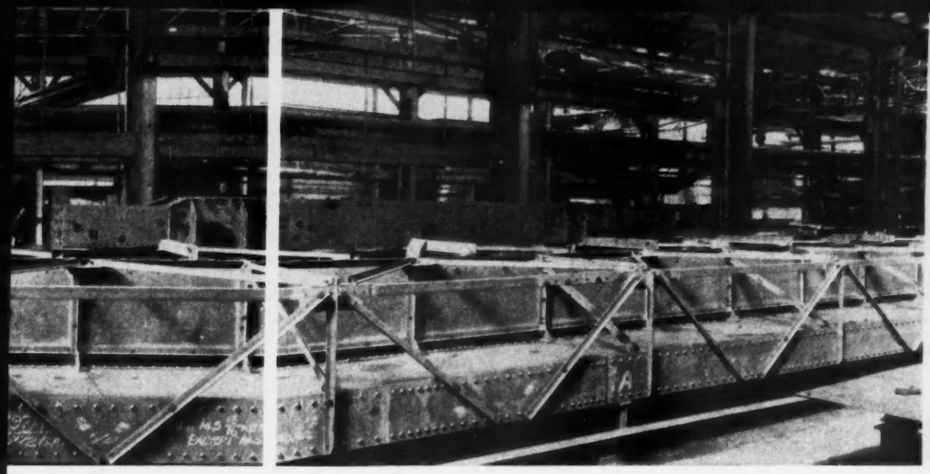
Automatic welding of a large pressure vessel.

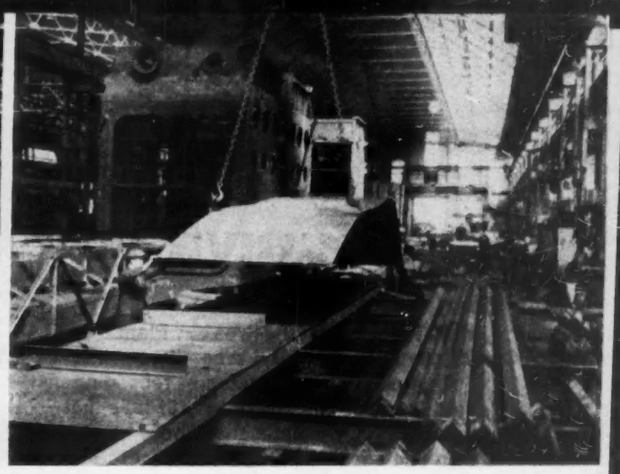
The large new stress relieving furnace in use.

Hot metal mixer of 800-tons capacity under assembly.









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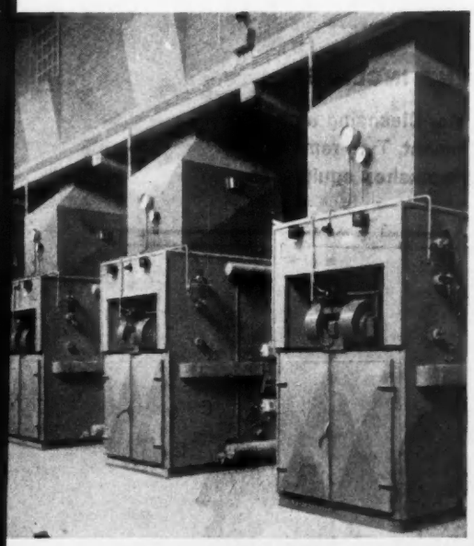

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A Redfyre "Emma" Boiler installation.

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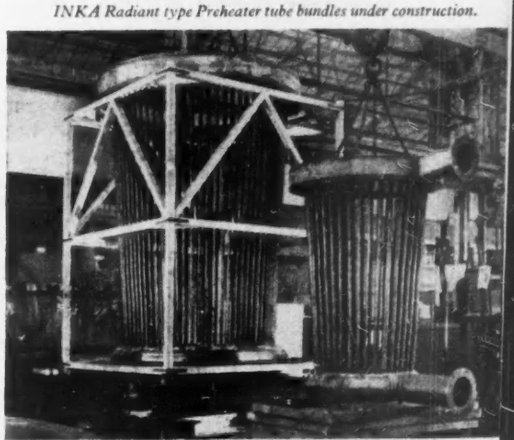
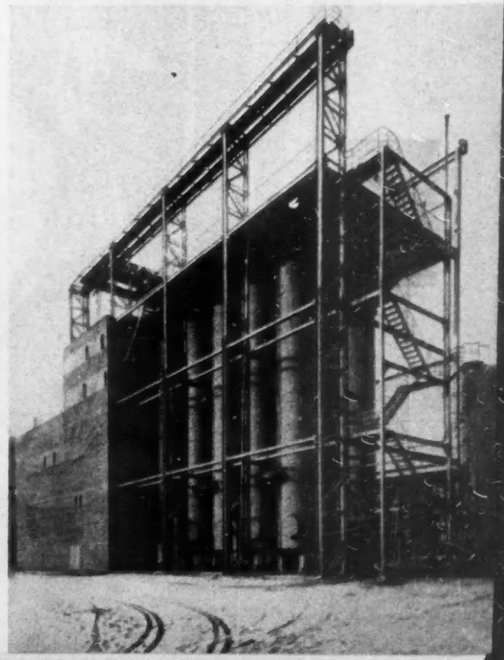
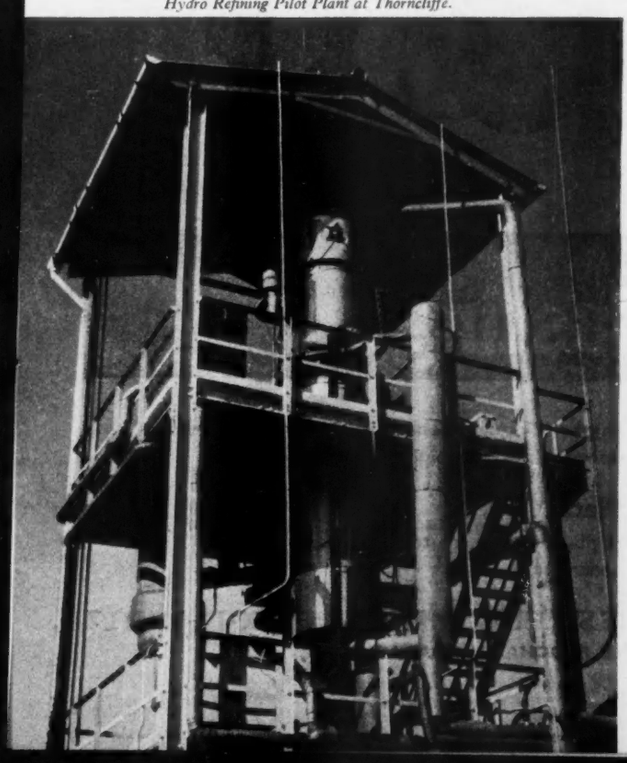
INKA Radiant type Preheater tube bundles under construction.



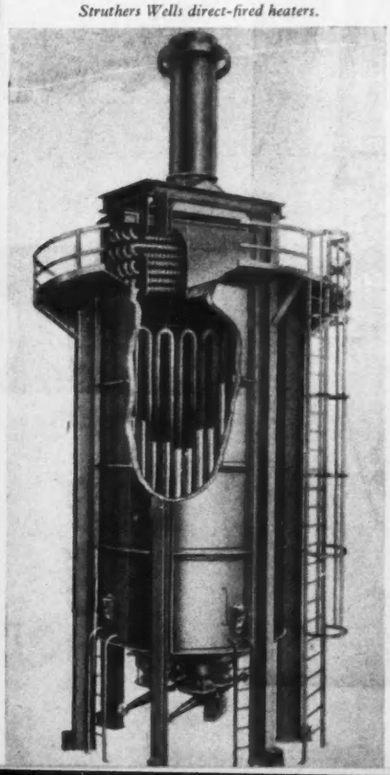
A typical Newton Chambers Bischoff high pressure purification plant.



Hydro Refining Pilot Plant at Thorncliffe.



Struthers Wells direct-fired heaters.



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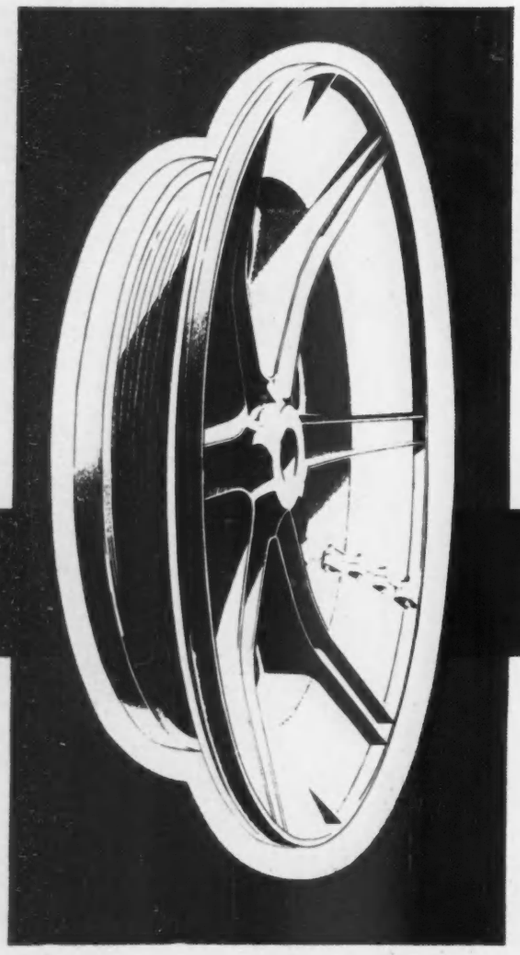

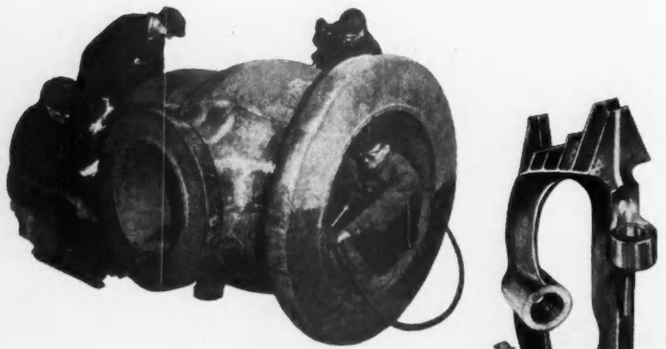

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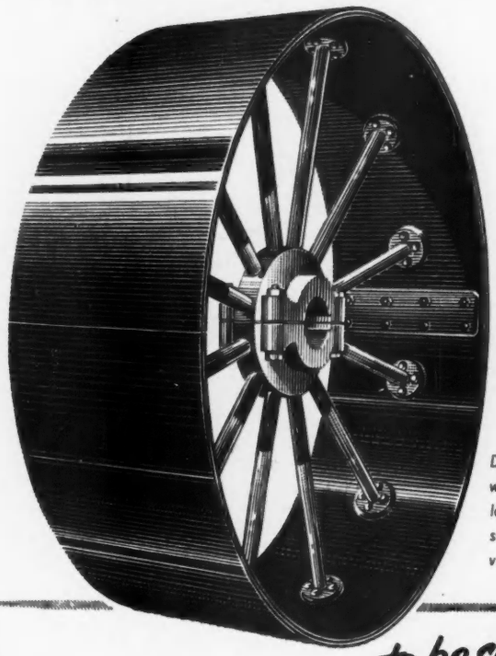

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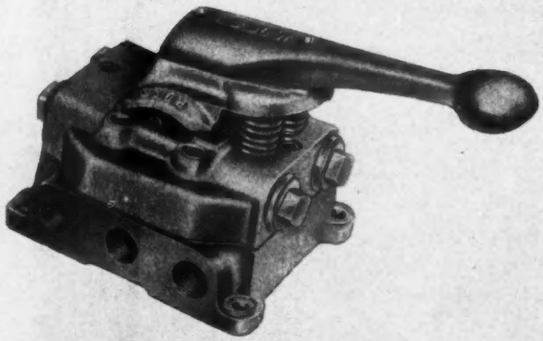

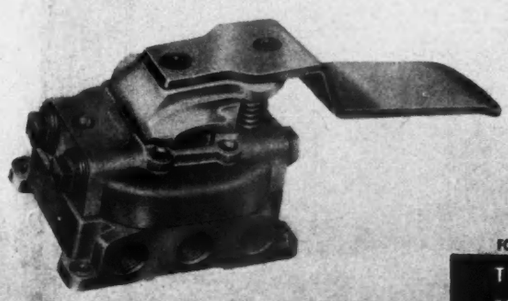

A Series of 3-way and 4-way Valves of robust construction in $\frac{1}{4}$" and $\frac{3}{8}$" B.S.P. Sizes.

Designed for Manifold Mounting and easily convertable to Hand or Foot Operation.

Available as Two Position Non-Locking or Two and Three Position Locking Type Valves. Foot Valves with Single or Double Treadle.

Suitable for Air Pressures up to 125 P.S.I.

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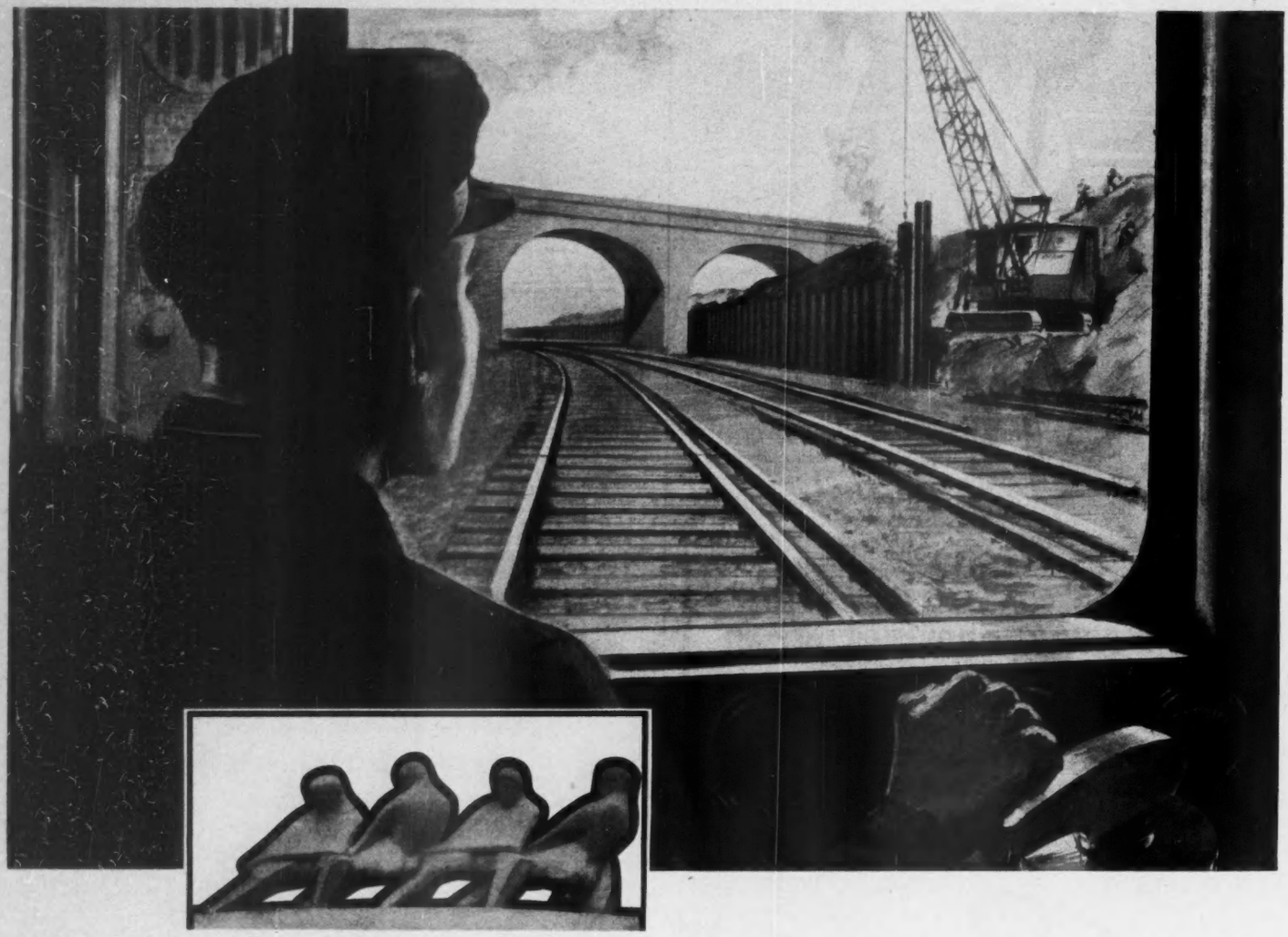
PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1 WORKS: DARLASTON, South Staffs, & BELFAST.



TeamWork speeds modernisation

Taylor Woodrow's contribution to the great work of the modernisation of British Railways could only have been made by an organisation itself great in resources of skill, experience and equipment.

This company is proud to have been entrusted with several major contracts connected with Extension of Electrification for the British Transport Commission, British Railways—Southern Region. These include bridge works and track widening at Swale Halt, Sittingbourne, carriage cleaning building and sidings at Grove Park, inspection and repair workshops and sidings at Selhurst, together with signal boxes, relay stations and ancillary works elsewhere.

Other important contracts for Southern Region completed and in progress include the construction of a briefing and maintenance depot, carriage inspection buildings, carriage washing plants, lengthening of platforms and ancillary buildings. Current work includes the construction of the 1,000 ft. long perishable-goods building, together with 4,000 yards of sidings at Hither Green.

The company is also engaged on major railway projects overseas, including the £9 million—200 miles long railway in French Equatorial Africa being constructed by Taylor Woodrow in association with Utah Construction Company of San Francisco and Compagnie Industrielle de Travaux of Paris.

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BUILD EVERYWHERE

BUILDING AND CIVIL ENGINEERING CONTRACTORS

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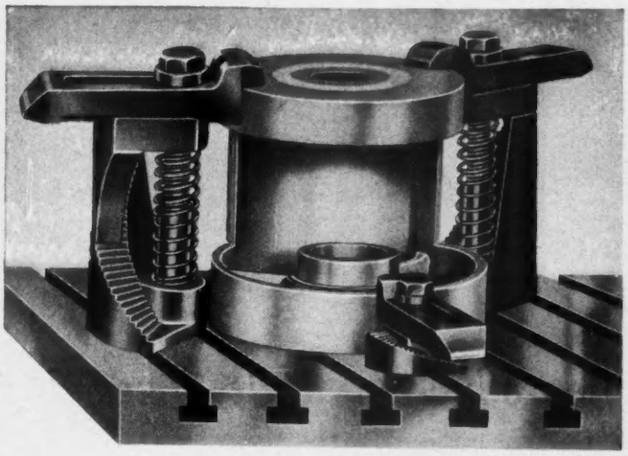

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A range of popular sizes so suit any T slot or clamping height.
No loose parts to lose.
Each size adjustable for height.
Any quantity Ex stock.

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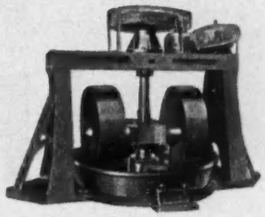

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CLEAN OIL-FREE AIR

Illustrated is one of the Type HSP machines with a capacity of 180 c.f.h. at 5 lb pressure.

Designed especially to meet the ever increasing demands of Industry for CLEAN OIL-FREE AIR **"ALCOSA"** type HSP and GSP Positive Pressure Blowers are available in a range of 6 sizes. (Type HSP up to 5 lb pressure. Type GSP up to 10 lb pressure.) Lightweight, vibrationless, silent and easily installed, **"ALCOSA"** Oil-Free Blowers are subjected to exhaustive tests during manufacture to ensure long and efficient operation.
Many special variations of standard models available. Let us know your requirements; we will gladly advise.
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"ALCOSA" ***products include:*** Blowers, brazing equipment, gas and oil burners, fans, furnaces, portable forges, soldering and tinsmith equipment, etc.

FOR EFFICIENCY ALCOSA **IS THE ANSWER**

PRINT ROOMS

The LEDA Reproduction Unit gives high quality dyeline (diazo) print output with simplicity of operation. Today, the LEDA is being used in hundreds of print rooms throughout the world, which is an indication of its superiority in this field of printing. If you have the need to increase your print production it would pay you to investigate the potentials of this modern combined plan printer and developer—the MASON manufactured LEDA Reproduction Unit.

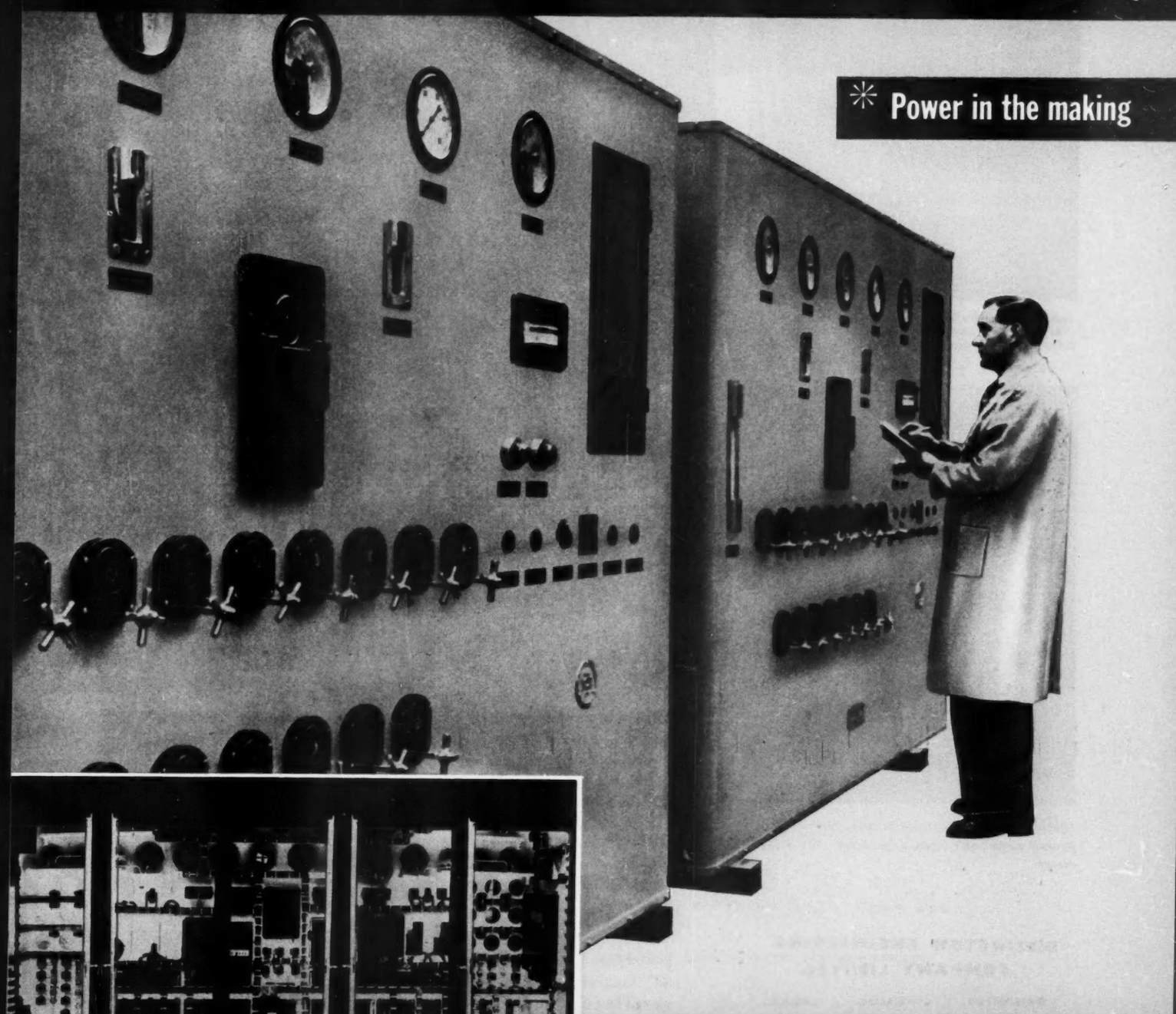
E. N. MASON & SONS LTD., Arclight Works, Colchester. Tel. 5191

and at

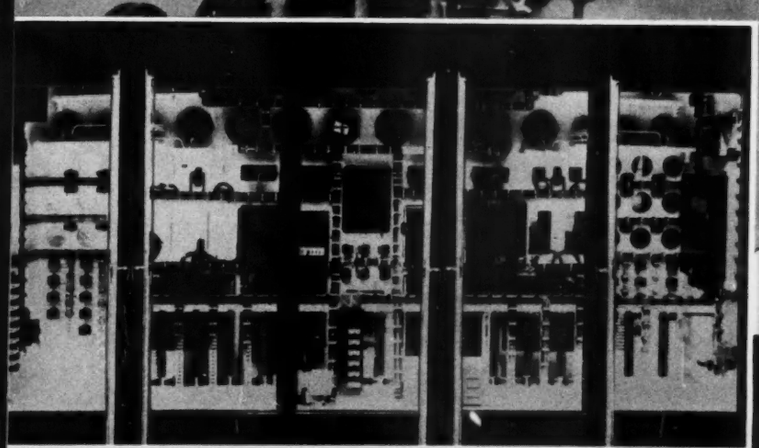
LONDON GLASGOW MANCHESTER BIRMINGHAM SHEFFIELD LIVERPOOL LEEDS BRISTOL

Instrumentation FOR TURBO-GENERATING PLANT

✳ Power in the making



A control panel for a PARSONS hydrogen cooled generator.



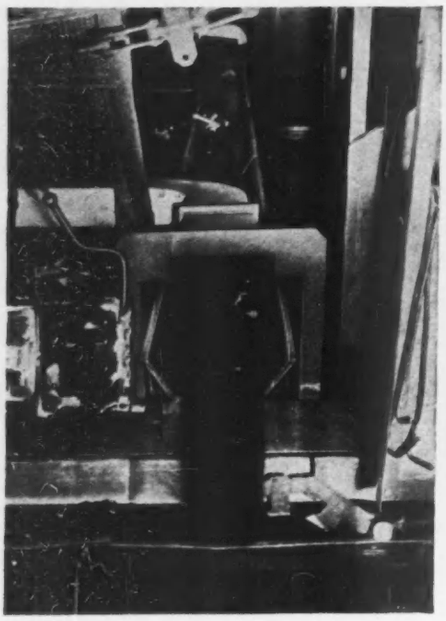
The rear of a PARSONS turbine gauge board.

✳ Instrumentation work by PARSONS grows in quantity and importance as turbo-generator sizes, steam pressures and temperatures increase. The control of power station generating plant is vital and the instrumentation must be robust and reliable.

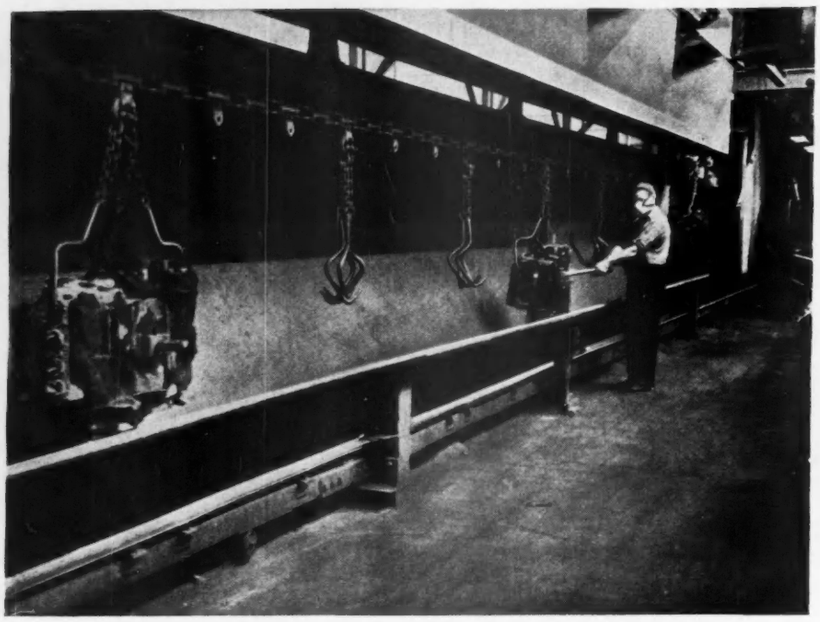
TURBO-GENERATORS TRANSFORMERS CONDENSING PLANT

PARSONS

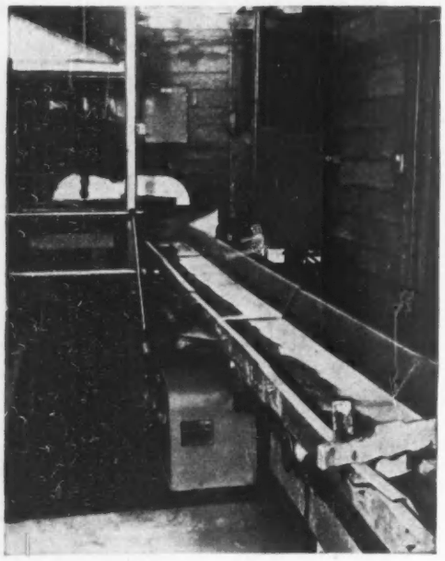
C. A. PARSONS & CO. LTD.
HEATON WORKS · NEWCASTLE UPON TYNE 6



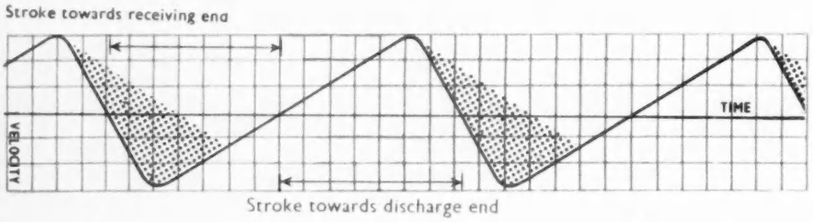
Shaker conveyor discharging scrap on to a similar conveyor. (The photographs reproduced in this advertisement are published by courtesy of the Ford Motor Company Limited.)



Sand cores and risers from engine component castings fall on to a shaker conveyor which carries them to a rotary scrap breaker and sand separator.



Shaker conveyor showing type G20 drive, driven by a 20 h.p. flywheel motor; this robust drive delivers high peaks of energy.



SHAKER CONVEYING

in a mechanised foundry

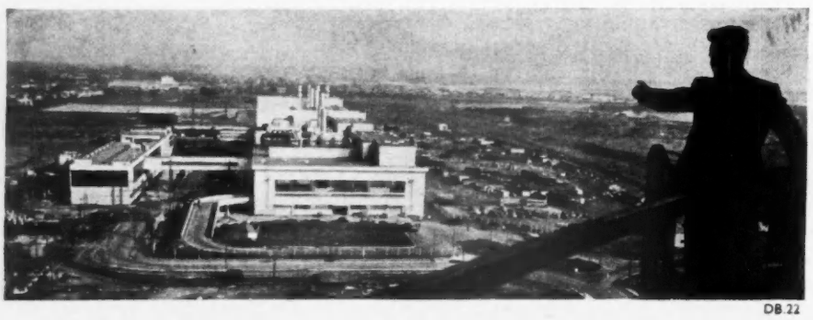
The Distington-Goodman shaker conveyor is not a jigger conveyor. Its troughs move in only one plane on ball-bearing rollers and propel material by variations in their rates of acceleration and deceleration (these are shown in the time-velocity curve above: the shaded areas represent the movement of material independent from the movement of the troughs).

Distington-Goodman shaker conveyors have been used for many years for loading and conveying coal and rock. Their robust all-steel construction makes them ideal for handling hot materials in foundries and cement clinker and sinter.

They are easily extended and contracted and can be made self-loading from stock heaps. Lines of troughing can be made to deviate through angles up to 90°. Conveying capacity depends upon several factors but would normally exceed 60 t.p.h. on the level.

DISTINGTON ENGINEERING COMPANY LIMITED

WORKINGTON · CUMBERLAND · ENGLAND



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confidence in Brymill

A busy day ahead and no anxiety about steel,

because the order went to Brymill.

Whatever the size or specification, Brymill Steel

is scientifically tested to ensure a reliable product.

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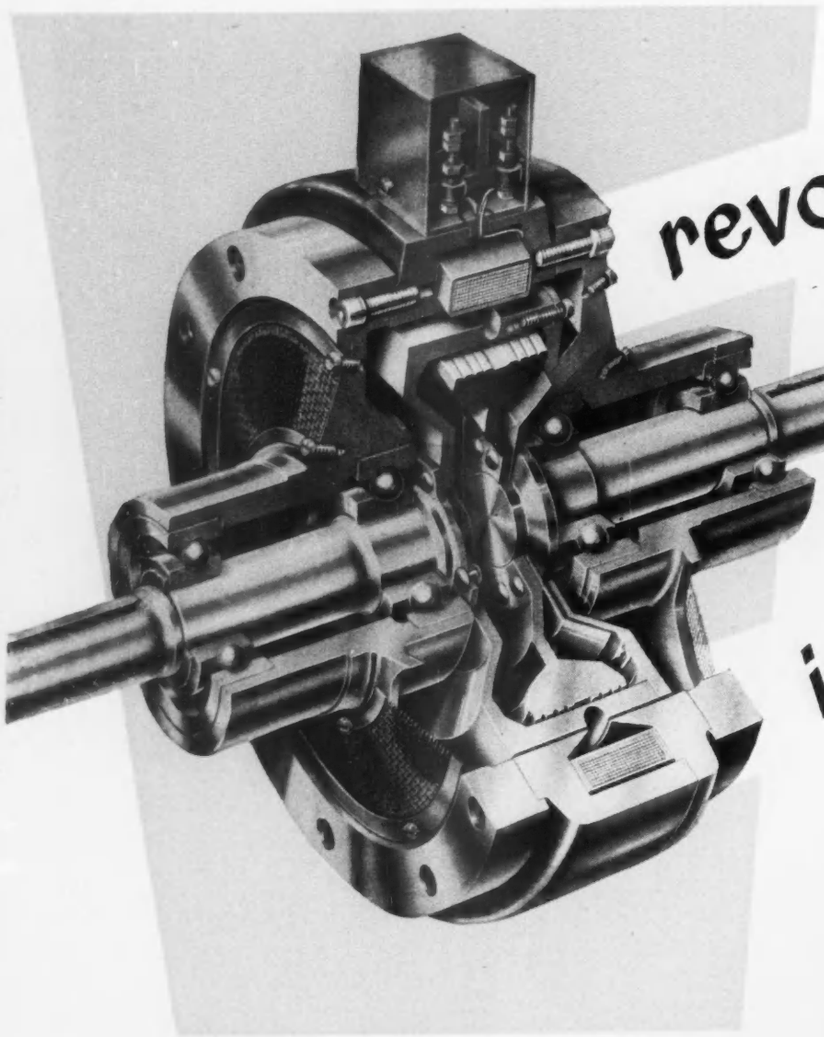
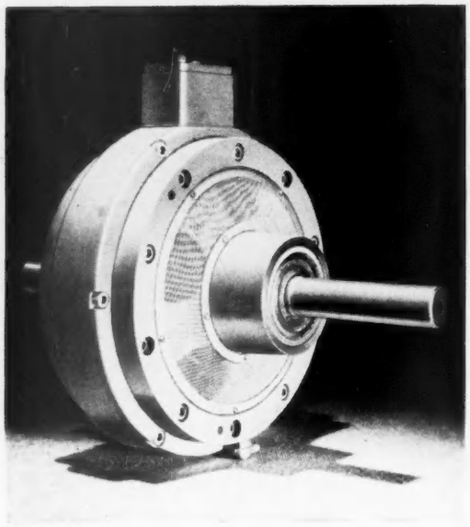
BRITISH ROLLING MILLS LTD.
BRYMILL STEEL WORKS · TIPTON · STAFFS



revolution

in rotation



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This is a positive coupling working on a new principle. It is NOT a magnetically operated clutch, and there are no plates to wear.

Driving and driven members are coupled by magnetically activated particles, giving perfectly smooth take-up and accurate control of torque. Eight standard units are made ranging from 1/3 to 200 lb/ft.

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AP/83

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The BRITISH ALUMINIUM Co Ltd

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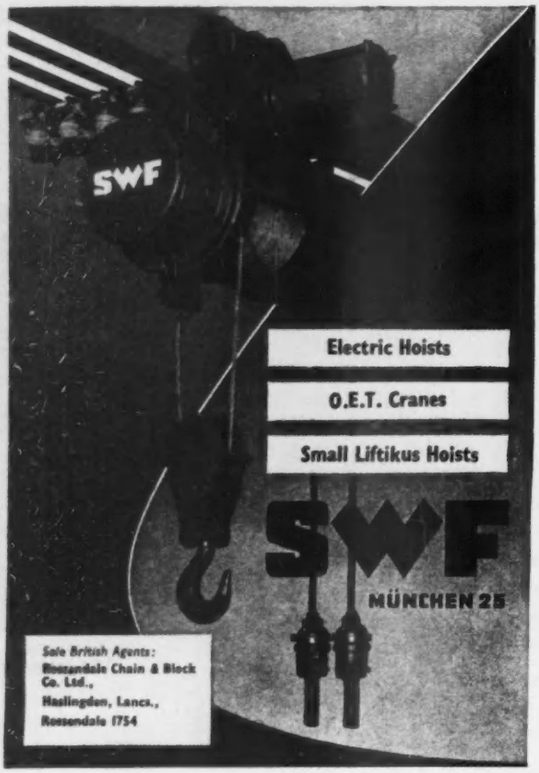

SWF,
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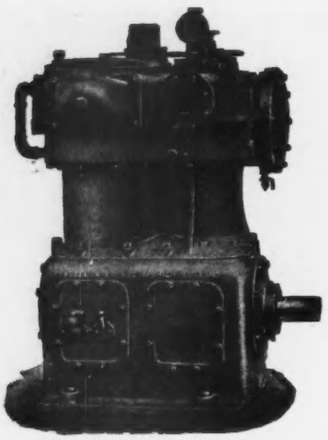
AIR COMPRESSORS

VERTICAL SINGLE-ACTING TYPE

SINGLE STAGE.	100 LB. PER SQ. IN.	1 TO 155 CU. FT. PER MIN.
	60 LB. PER SQ. IN.	1 TO 380 CU. FT. PER MIN.
TWO STAGE.	100 LB. PER SQ. IN.	200 TO 310 CU. FT. PER MIN.



FOR PARTICULARS OF THESE COMPRESSORS AND FOR OTHER TYPES AND SIZES.
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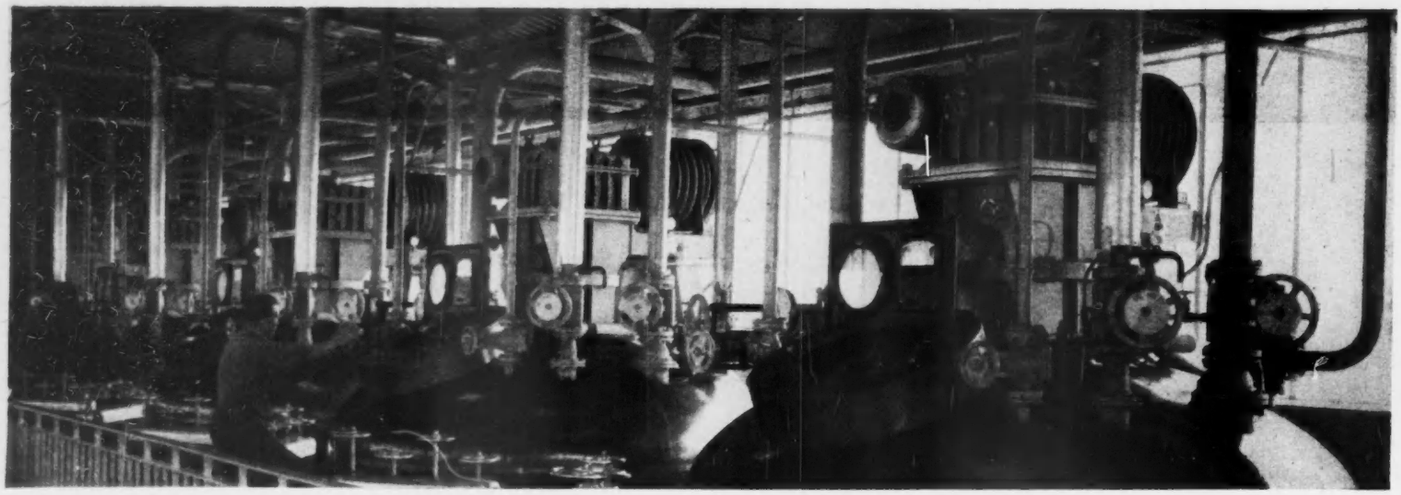
REAVELL & CO., LTD.
IPSWICH - ENGLAND

WISEMAN GEARS ARE UBIQUITOUS



Wiseman offer a range of gears so wide that it is possible to select the correct design for almost any application. In the world of gears Wiseman have long been renowned for high efficiency and reliability. Yet another difficult application successfully encountered is illustrated here. A group of hardening vessel agitators are driven through Wiseman T.E. Vertical Type Worm Reduction Gear Units at the Stork Margarine Work, Purfleet. Consult Wiseman with your next gear problem.

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Melting point	890° C
Electrical resistivity	60 microohm cm.
Hardness	500—1,000 V.P.N. according to heat treatment.
Coverage	Extremely uniform.

Kanigen

A HARD & CORROSION RESISTANT PLATE

Kanigen can be applied to all ferrous metals, aluminium, copper and brass. The plating plant at Oldbury has now been extended, two extra plating tanks are in operation and enquiries for jobbing plating are welcomed. Full information is available on request.

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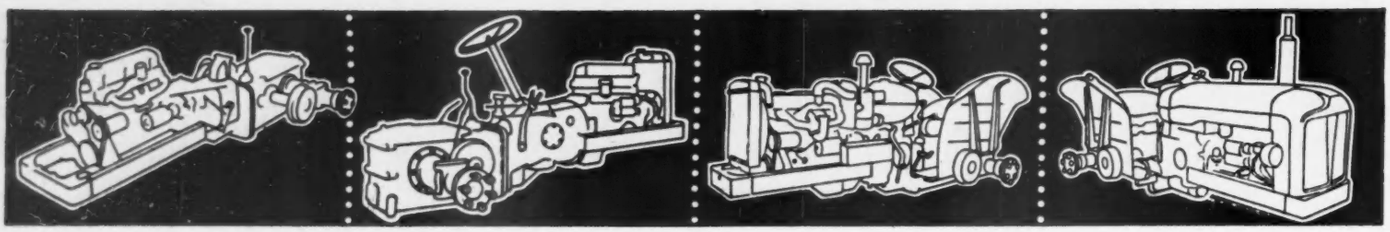

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...because Fordson Power gives the stamp of reliability, ensures high output at low cost, and because it has the backing of the Ford world-wide service and spares organisation. There are Fordson Industrial Equipment Units in the 30-40 b.h.p. and 40-50 b.h.p. classes, in more than 100 different assemblies. Fit Fordson and you get all the benefits of quality mass production from Ford's famous Dagenham factory, the biggest producer of mobile power units. Fit Fordson, the unit tailor-made to your requirements.

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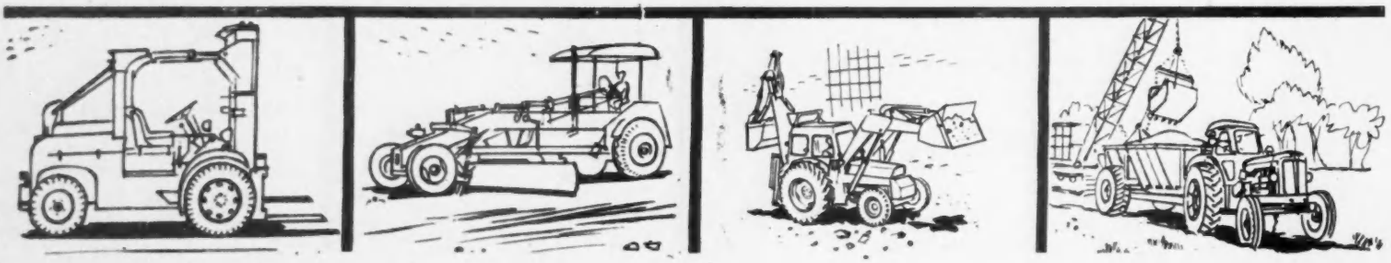

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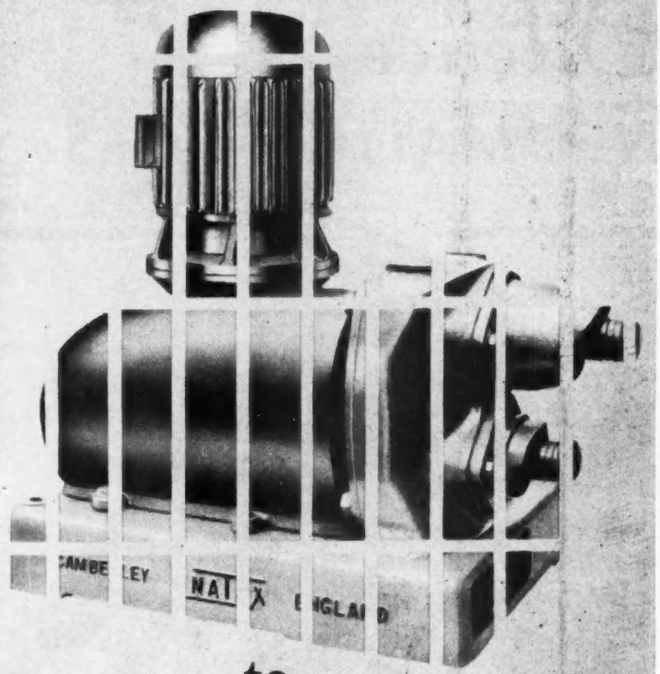

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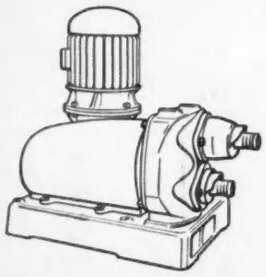
The whole pump body is lined with Linatex rubber using Linatex valves and diaphragm.



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PNEUMATIC TOOLS

NO NOISE
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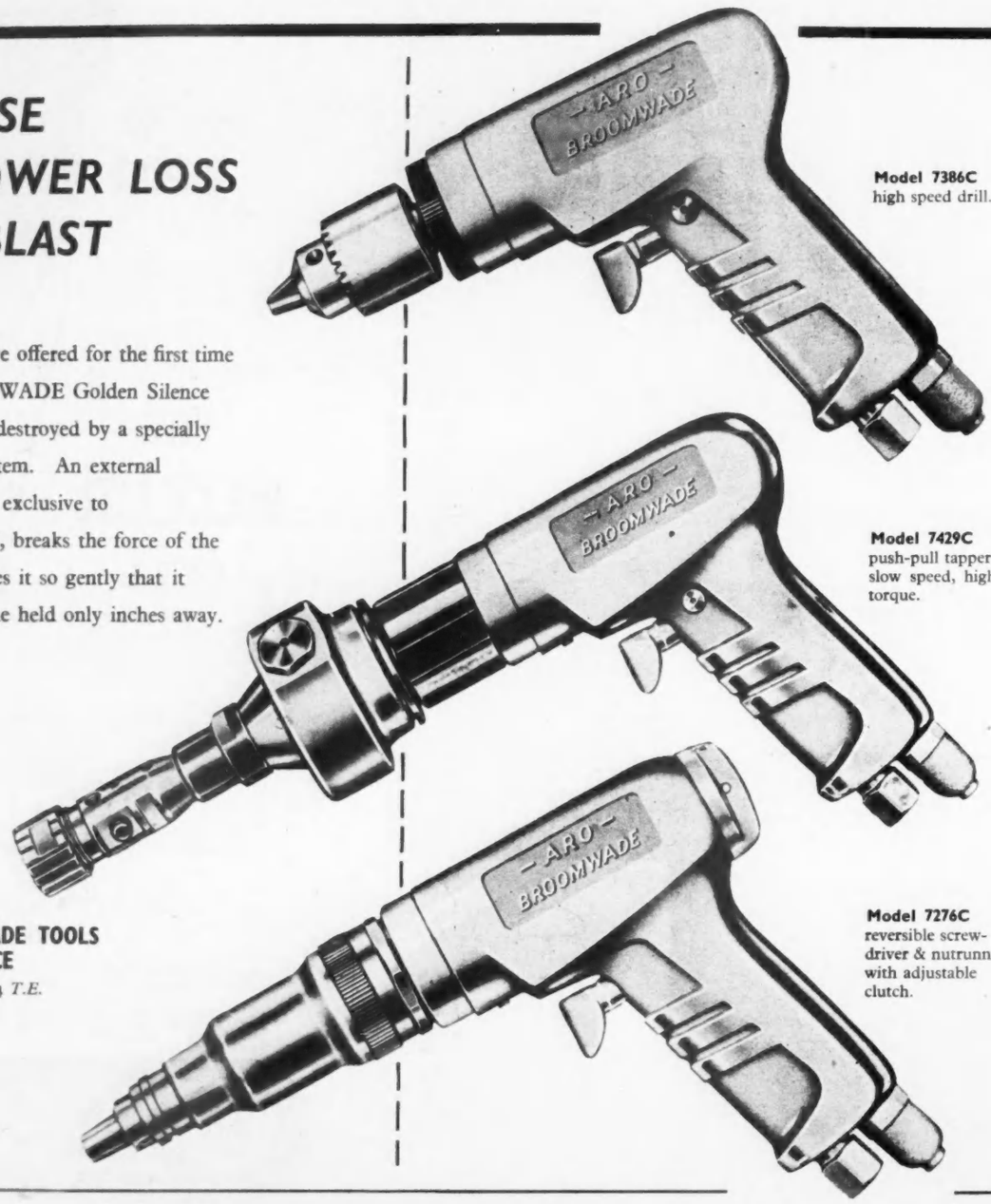

Model 7386C high speed drill.

Model 7429C push-pull tapper; slow speed, high torque.

Model 7276C reversible screw-driver & nutrunner, with adjustable clutch.

Only ARO-BROOMWADE TOOLS have GOLDEN SILENCE

Write for publication No. 444 T.E.

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AIR COMPRESSORS & PNEUMATIC TOOLS

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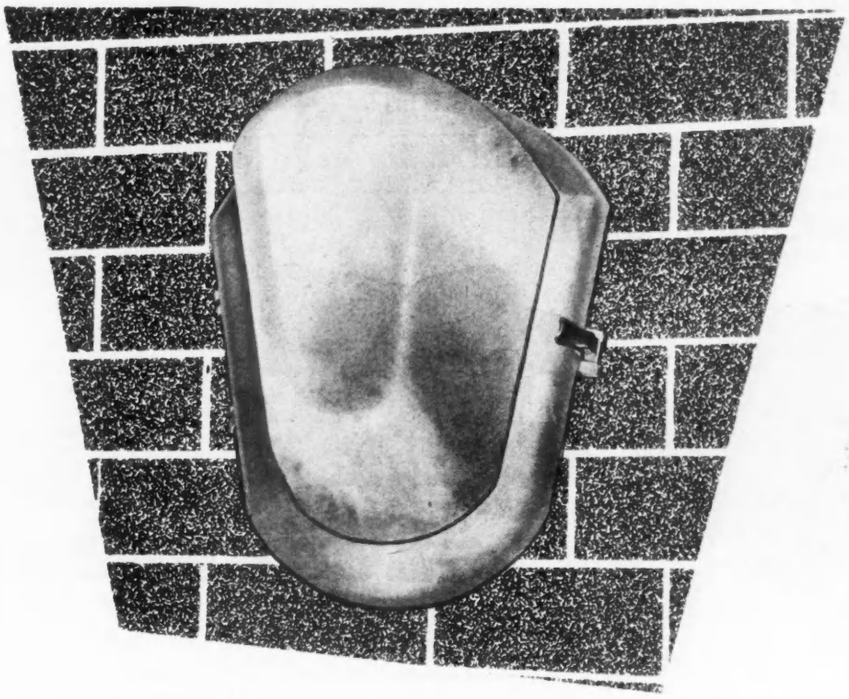
BROOM & WADE LTD., P.O. BOX No. 7, HIGH WYCOMBE, ENGLAND. *Telephone: High Wycombe 1630 (10 lines)* *Telegrams: "Broom", High Wycombe (Telex)*

667 SAS

G.E.C. 'LIMPET' LANTERN
for SIDE ROAD lighting



The lantern has been designed for side road lighting using two 60 watt Osram Tungsten Lamps or one 80 watt Osram Mercury MB/U or MBF/U Lamp.

New features include :—

- ✳ Die-cast light alloy body arranged for wall mounting, thus dispensing with the necessity for columns and the obstruction they might cause in certain situations.
- ✳ Lamp operating gear, where necessary, housed within the body.
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- ✳ All surfaces smooth for ease of cleaning.

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PLATT MALLEABLE CASTINGS LTD.
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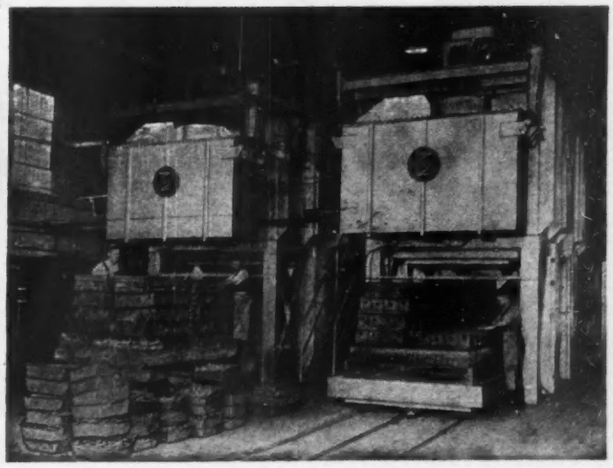

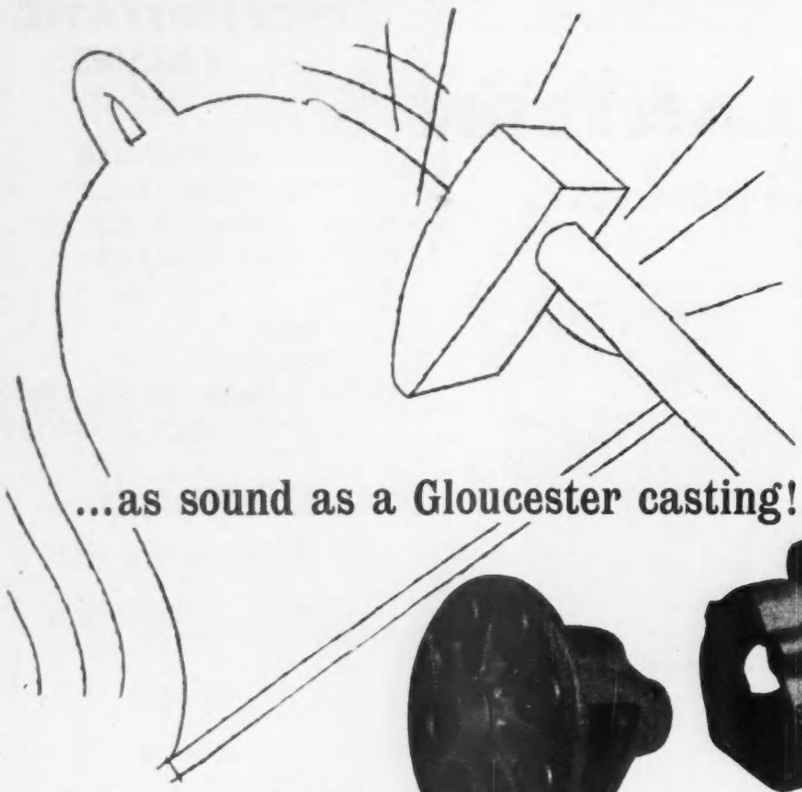

"As sound as a Gloucester Malleable casting" is no mere phrase. It is the result of a wealth of traditional skill and technical knowledge at every stage of production. Raw materials, melting and pouring processes, sand practice, moulding and core making, fettling and setting, all are exactly controlled to ensure castings that will measure up to to-day's exact engineering needs.

They are also accurately set under modern presses, using dies made to the limits required, to ensure that castings can be machined without costly delays.

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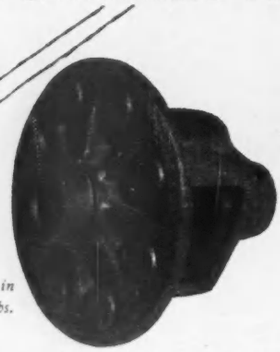
A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable		*Gloucester Lamellar Pearlitic Malleable*	
Elongation ..	18%	Elongation ..	5%
Yield Point ..	12 tons	Yield Point ..	24 tons
Tensile Strength	25 tons psi	Tensile Strength	35 tons psi

...as sound as a Gloucester casting!



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Vehicle Steering Box in Malleable Iron. Weight 6¾ lbs.

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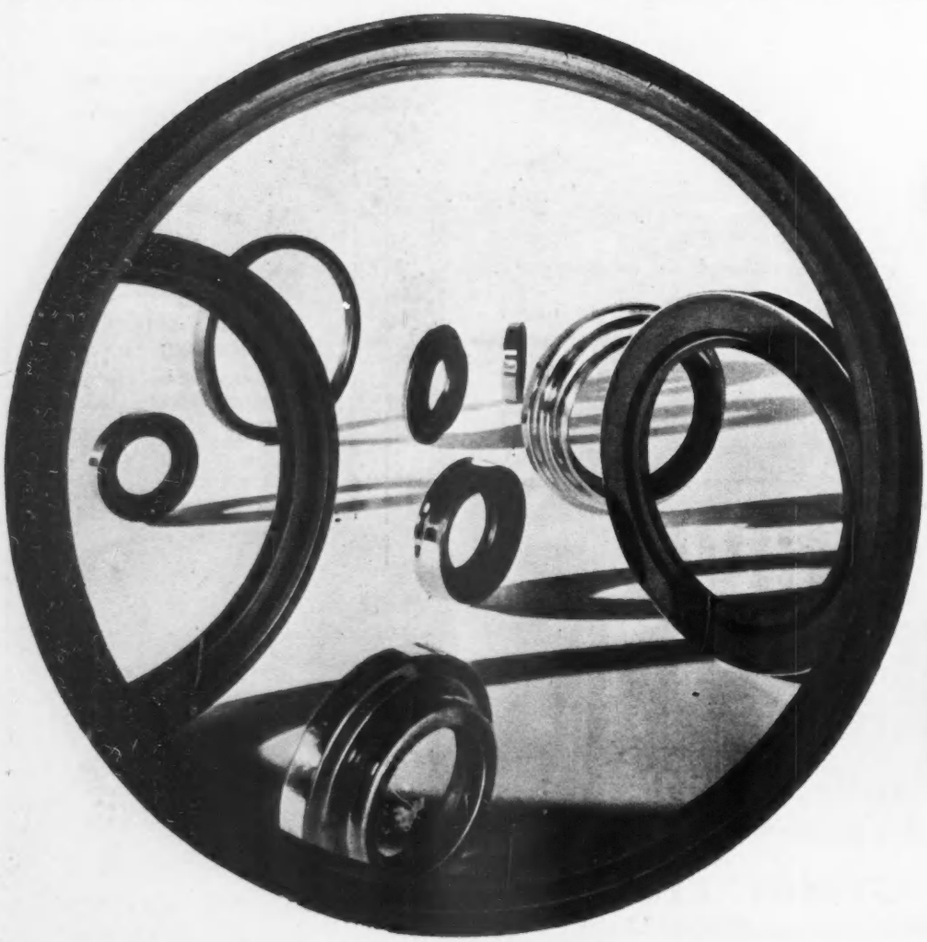

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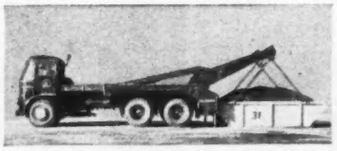
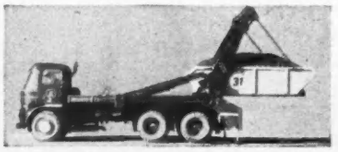
HYDRAULICALLY CONTROLLED SOLELY BY THE DRIVER from his cab the unit loads and unloads itself with detachable containers, one of which is transported whilst the other is being loaded. This, of course, effects astonishing savings in waiting time and labour costs.

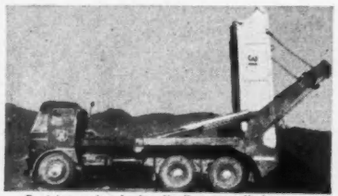


Rear independent hydraulic stabilizer jacks down. Load to be raised to Unit Deck.



Showing load being raised by retraction of hydraulically operated lifting arm rams.

Hydraulically operated rams fully retracted Load located on Unit Deck, jacks retracted.



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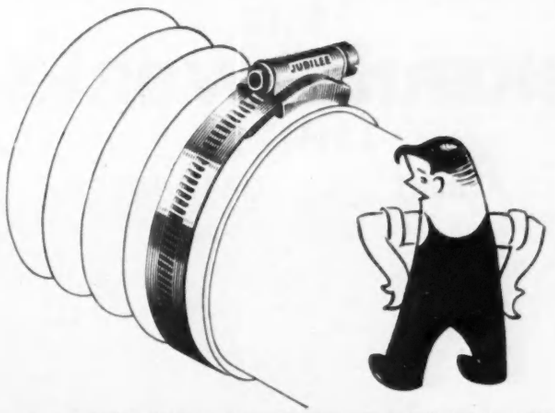

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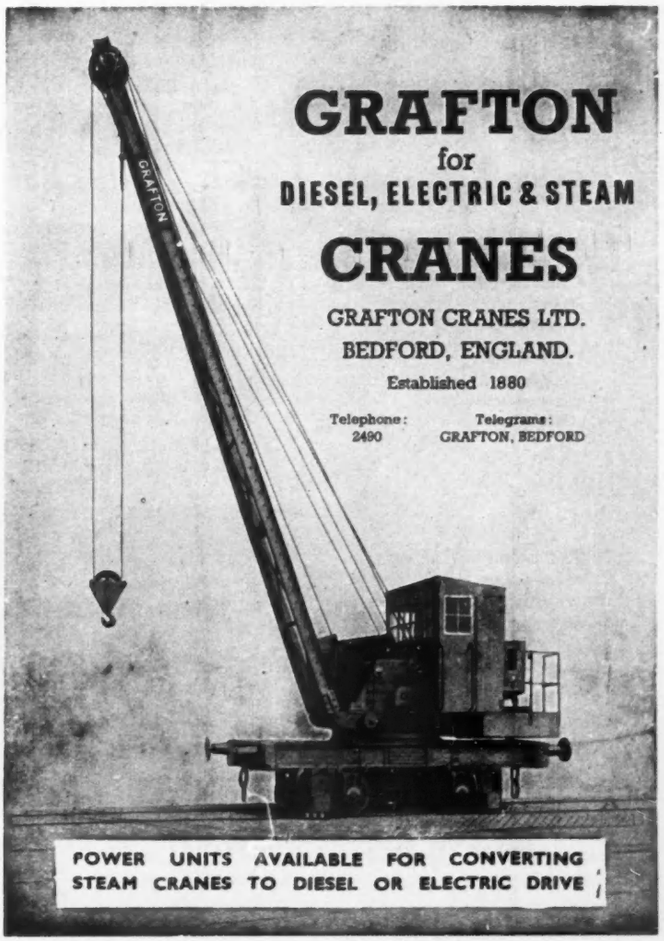

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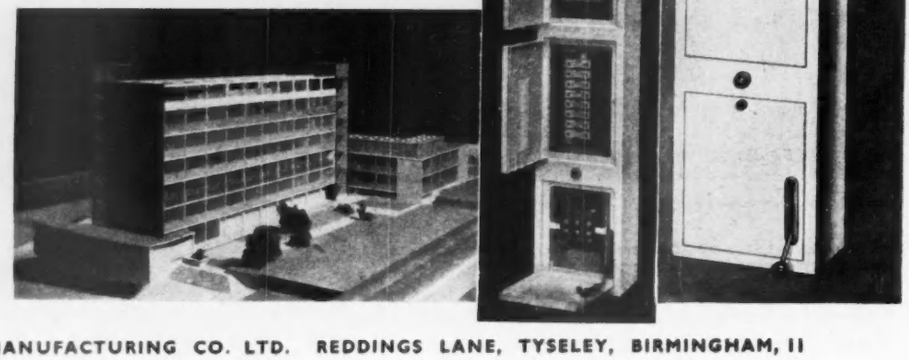
Fusing of the distribution section is 30 amp throughout.



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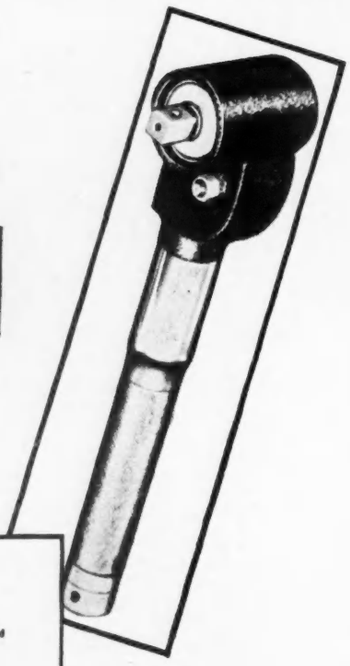

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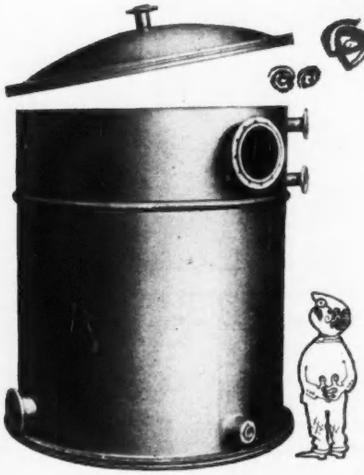

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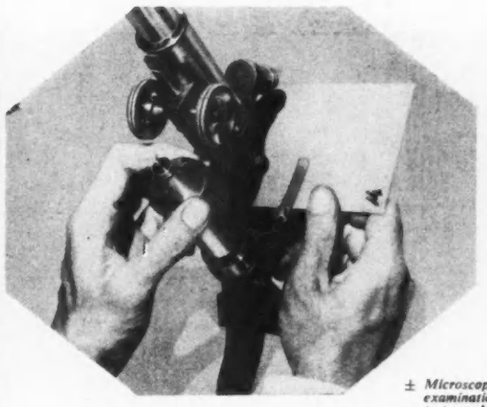

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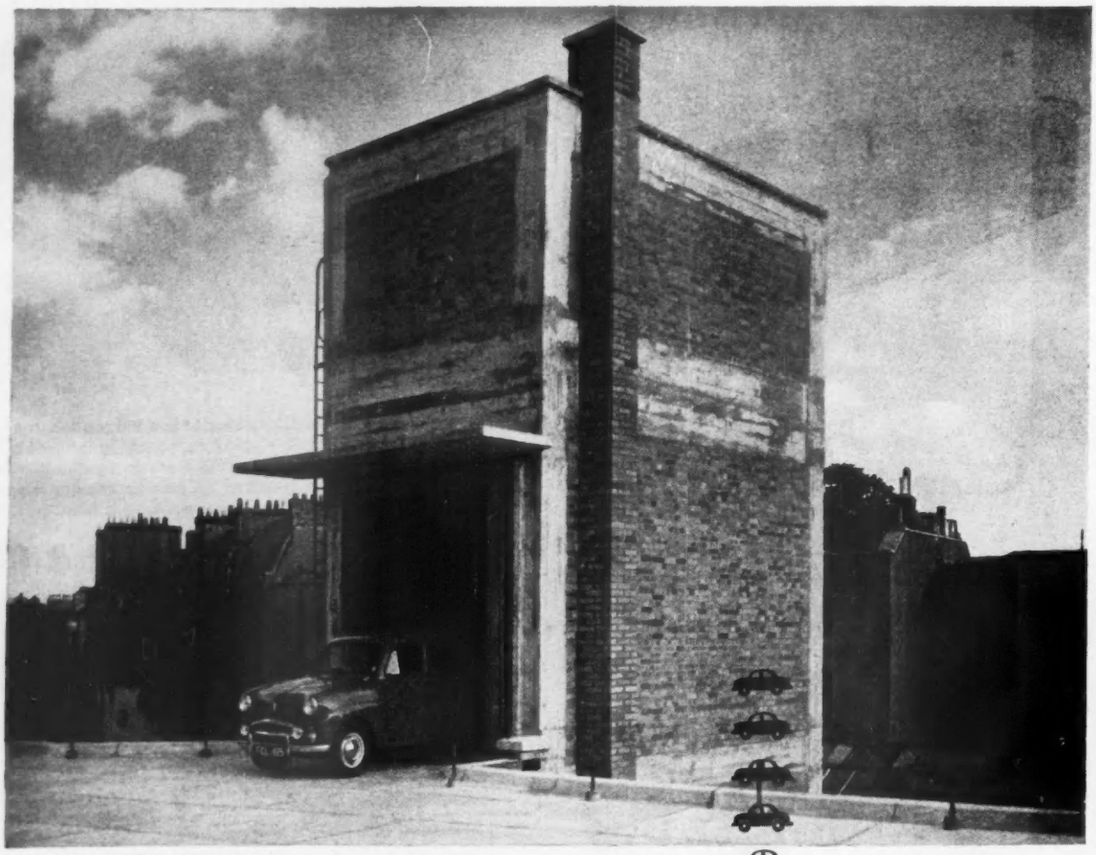

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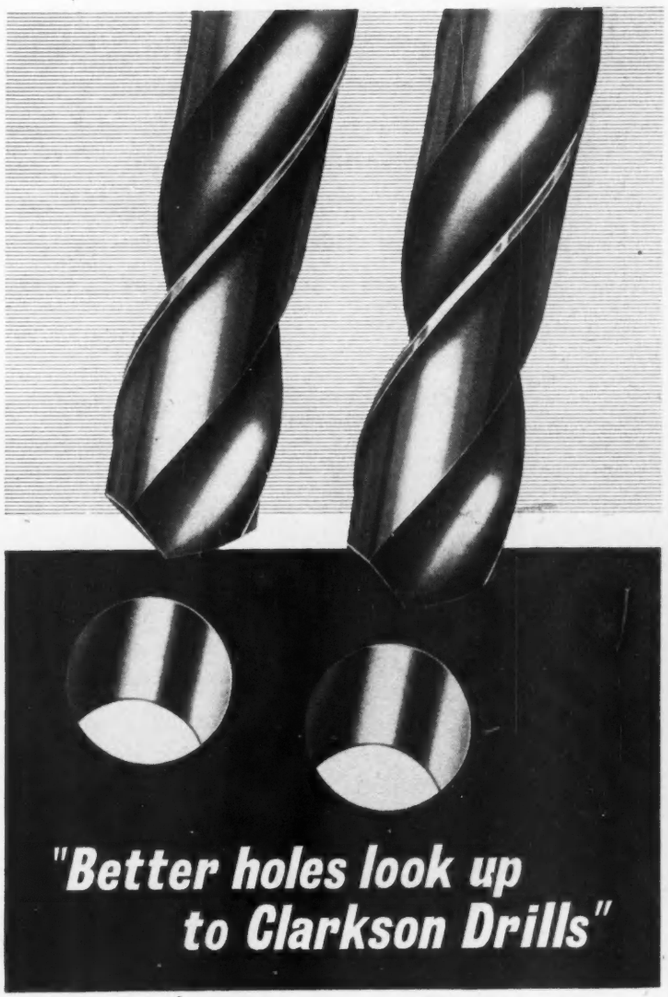

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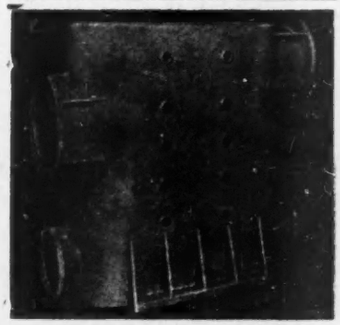

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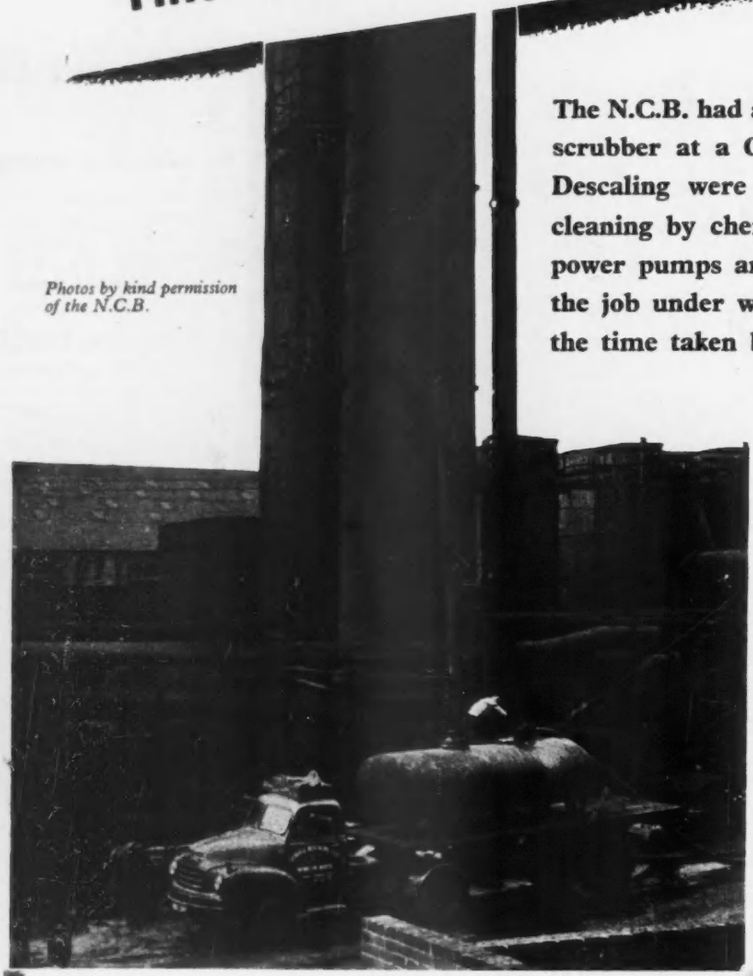

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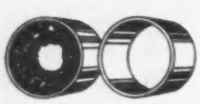

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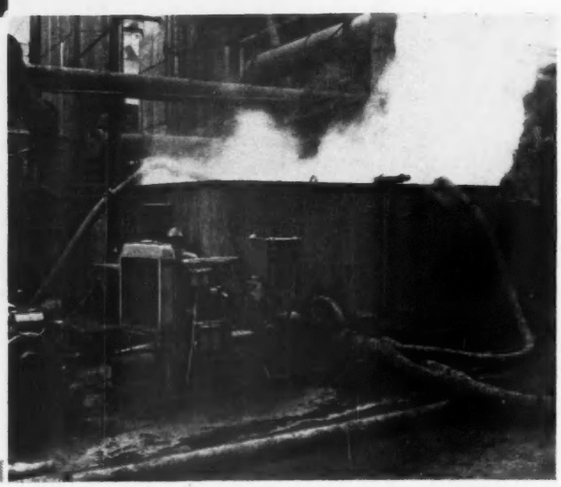

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Type NS55—6 tons capacity

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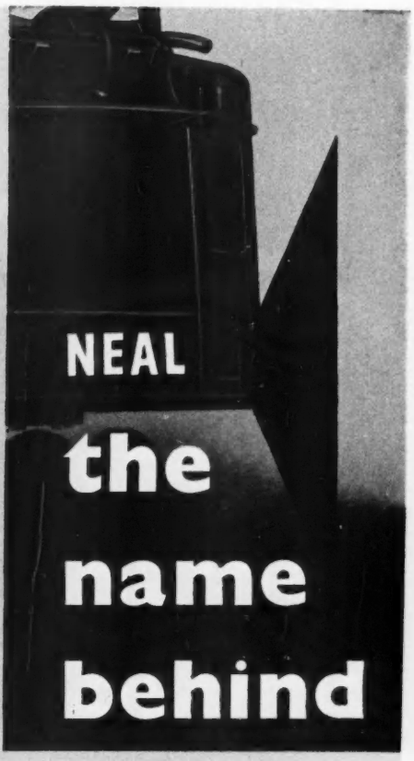

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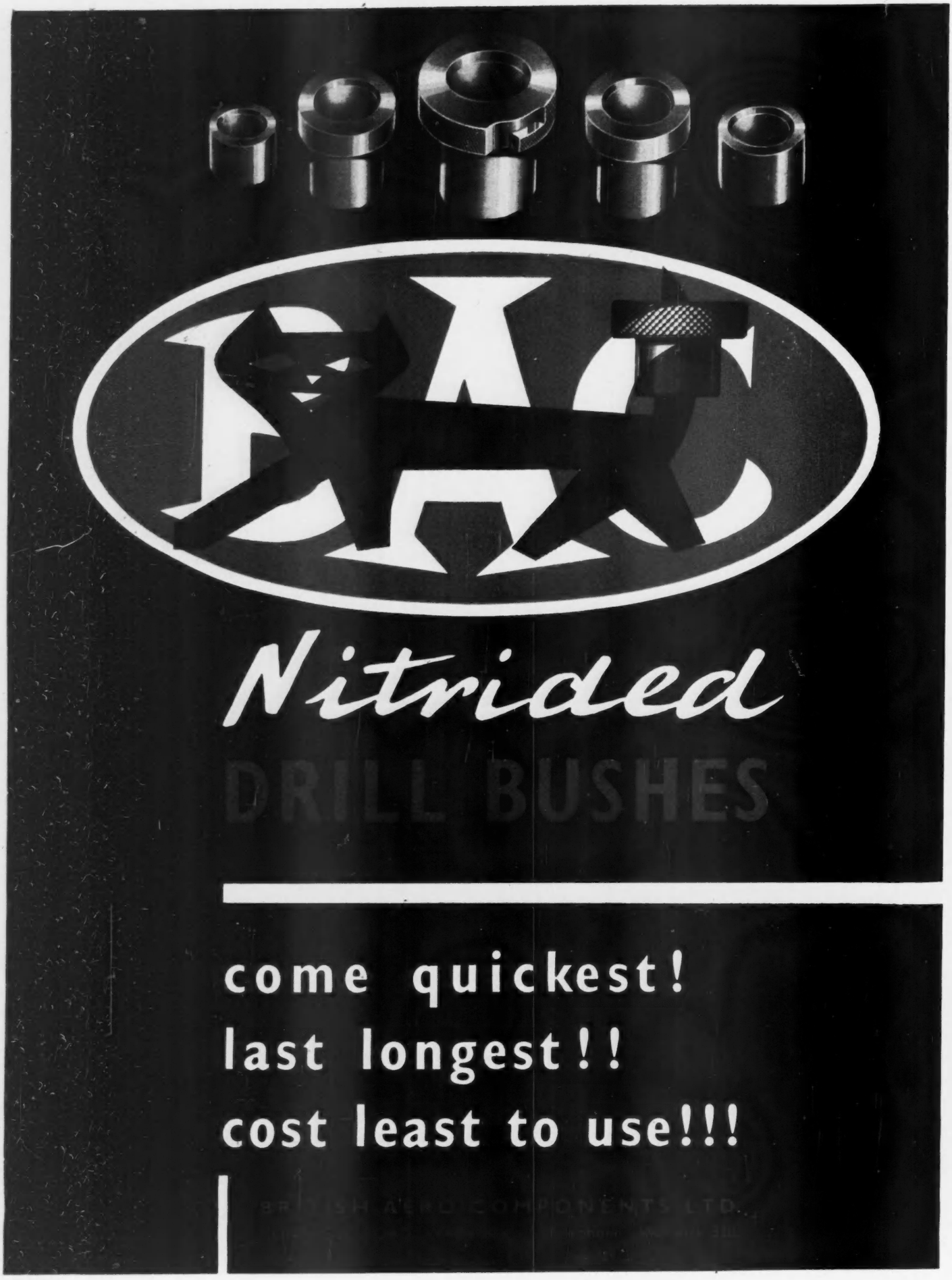
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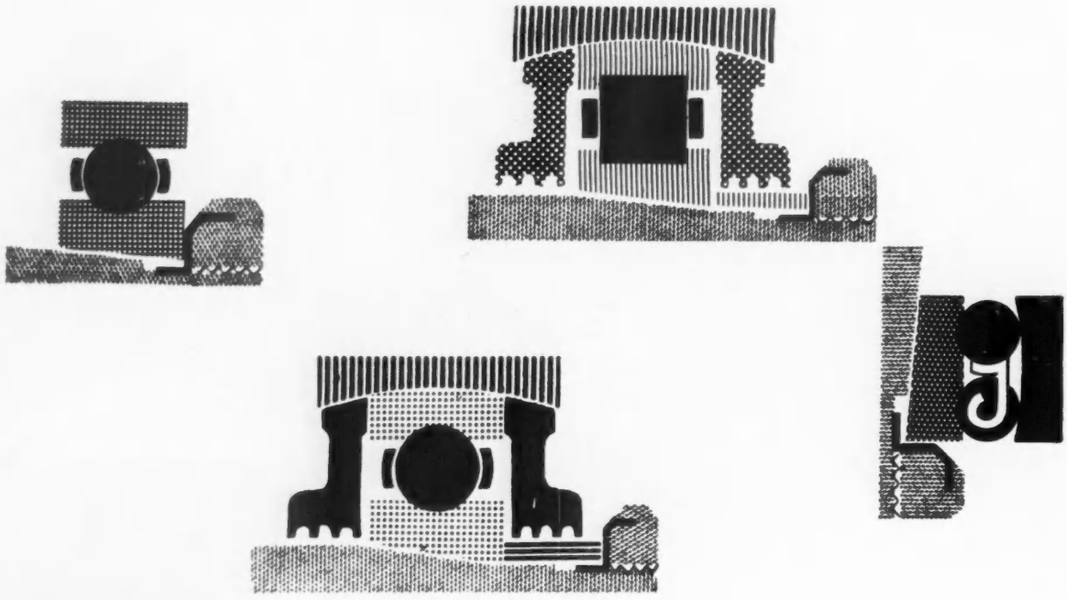

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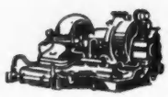

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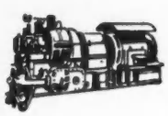

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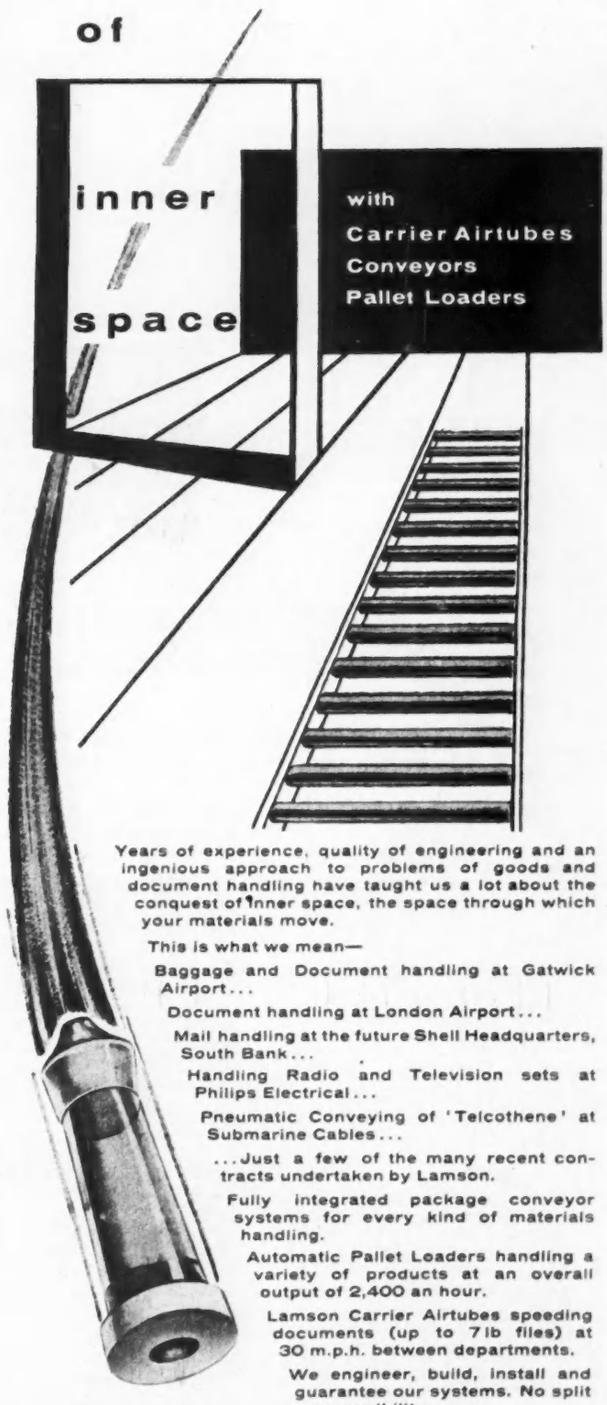

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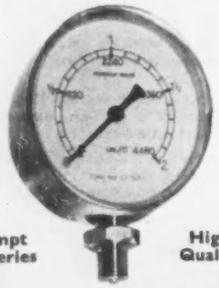

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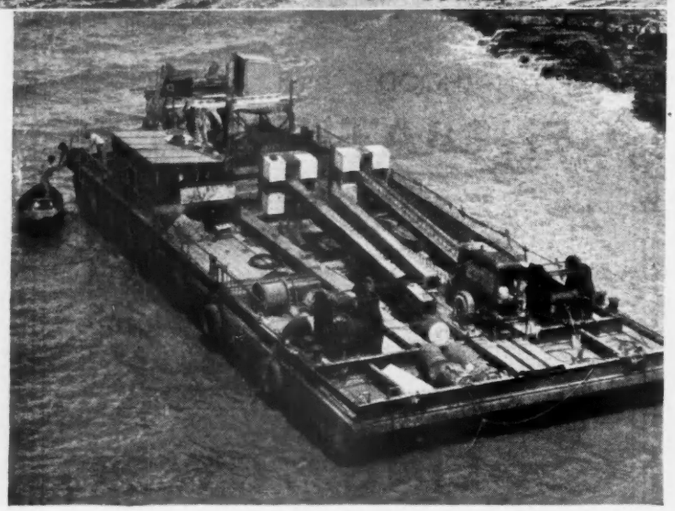

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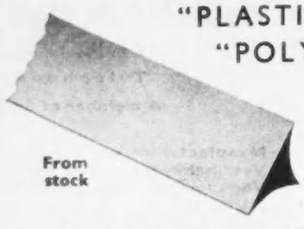

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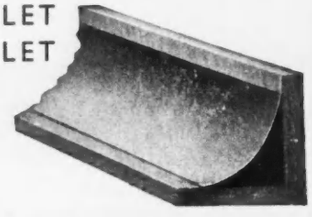

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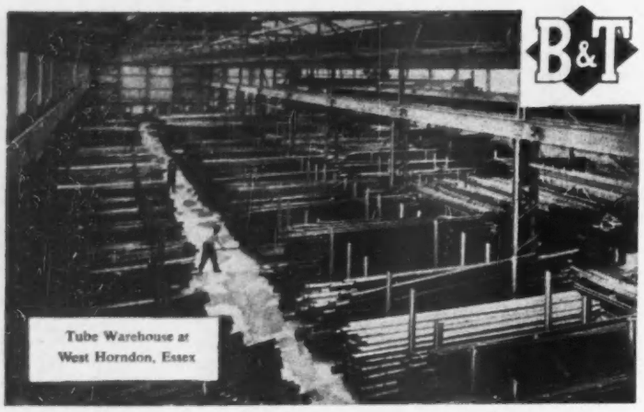

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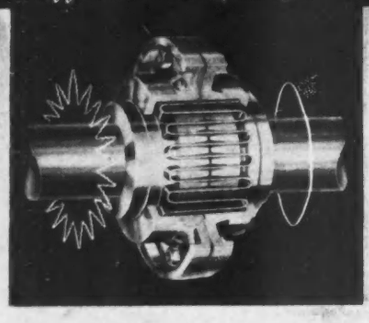

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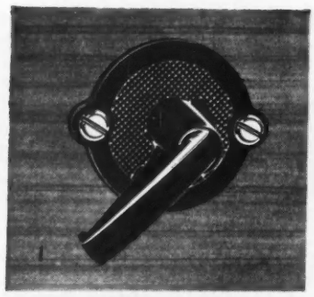

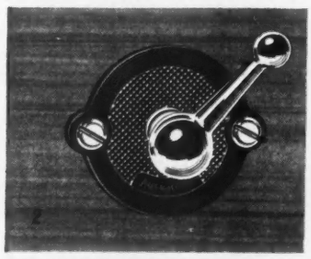

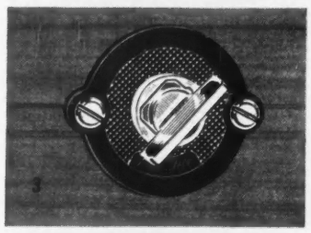

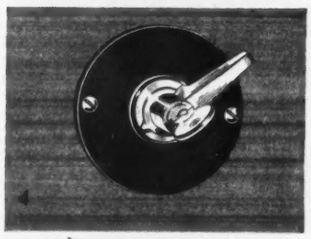

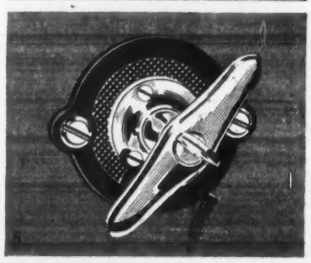

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To prevent tampering

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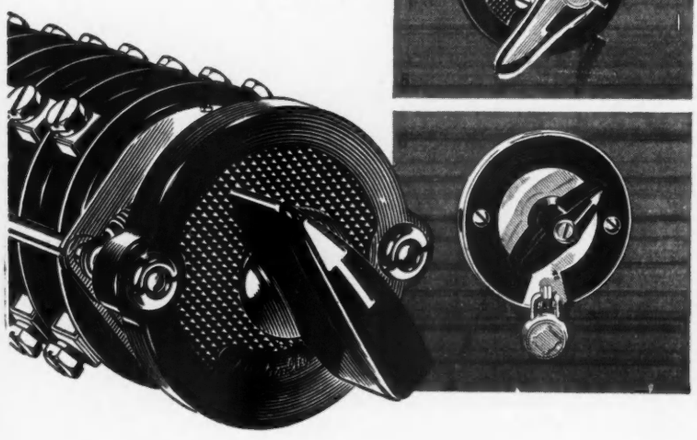

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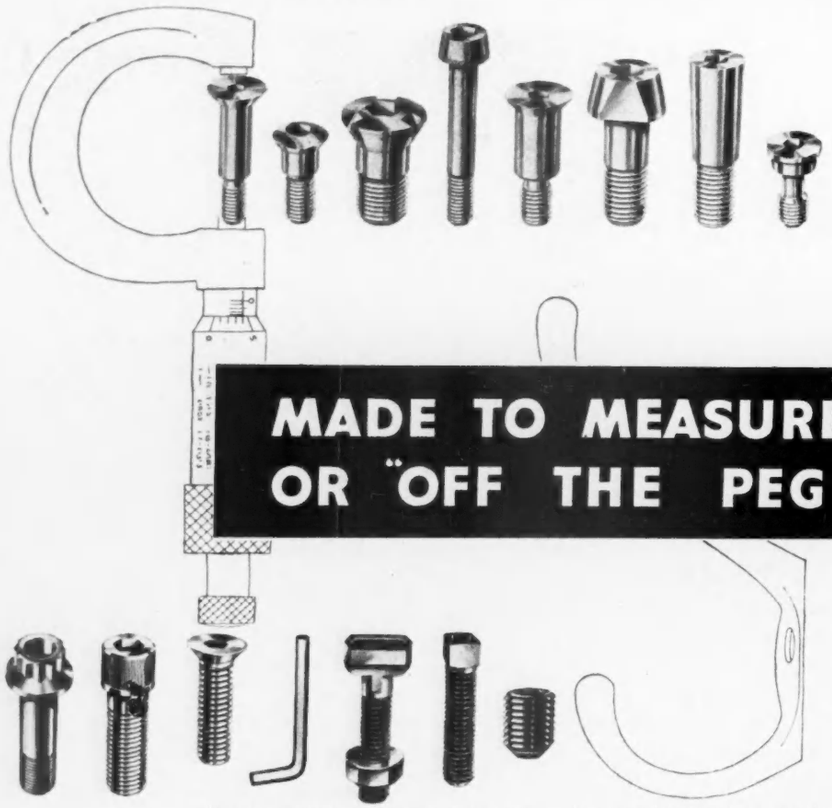

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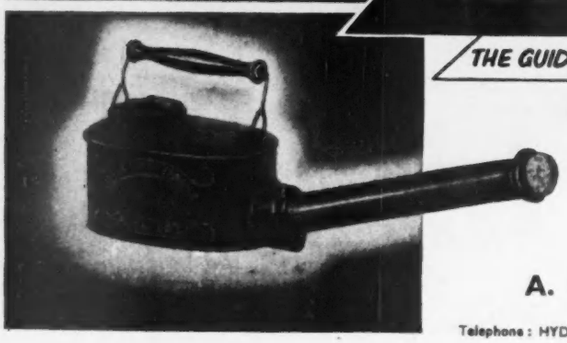

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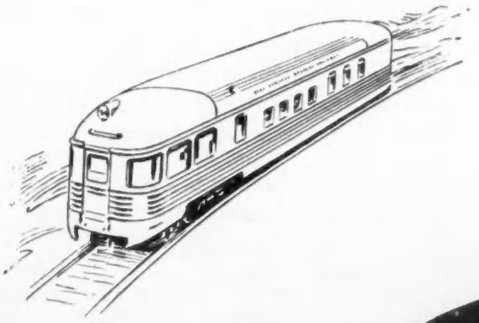

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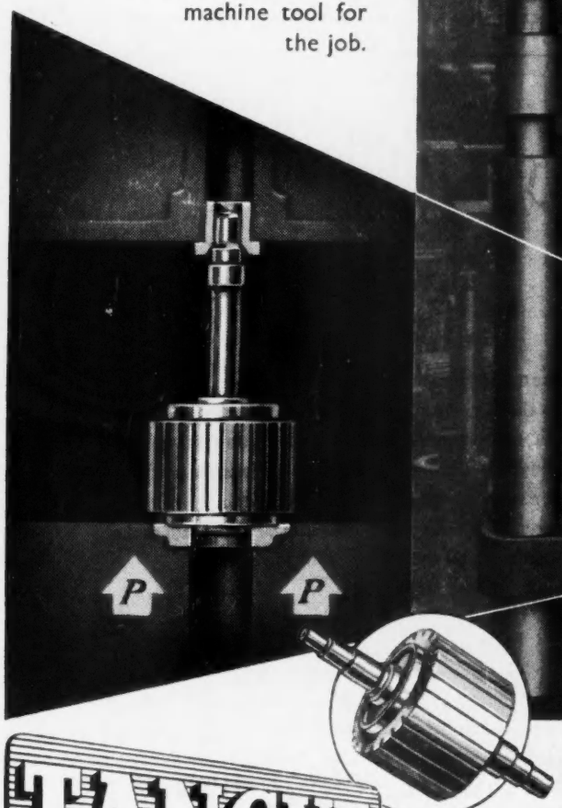

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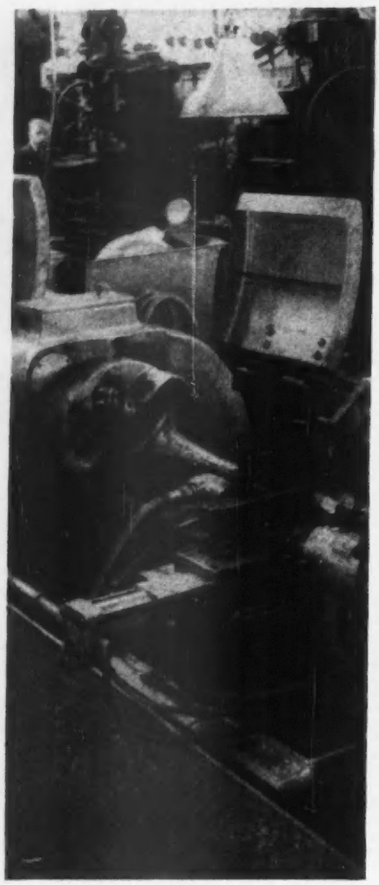

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EN39

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2" dia.	Oil quenched 830 C. Oil quenched 760 C. tempered 180 C.	82·1	17·5	61
4" dia.	Oil quenched 830 C. Oil quenched 760 C. tempered 180 C.	77·7	16·5	62

The benefits to be gained from the more highly alloyed case-hardening nickel steels, such as EN 33, EN 34, EN 36 and EN 39 include ease of heat-treatment, minimisation of processing distortion, and general reliability.

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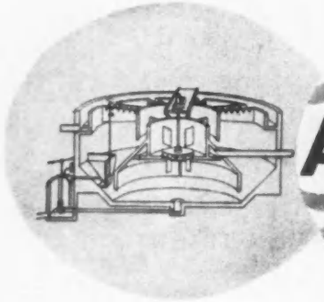

Accelator ...*soft, clear water*

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THE ENGINEER

No. 5406 SEPTEMBER 4, 1959 VOL. 208

BRITISH RAILWAYS A.C. ELECTRIFICATION

Evidence of impending work on converting the Shenfield-Southend section of the Eastern Region, British Railways, from 1500V d.c. to high-voltage, single-phase a.c. at 50 c/s was the subject of critical comment in an evening newspaper last week. Since a correspondent in our present issue also expresses concern at the decision to convert so soon after the line was electrified, it is worth while to recall that this is not the sudden change of plan which seems to have been assumed. While there continues to be controversy over some of the arguments in favour of industrial-frequency a.c. traction set forth in the B.T.C. report, "The System of Electrification for British Railways," of 1956, it must be agreed that this document made it clear that conversion of existing d.c. services from Liverpool Street to Southend and Chelmsford would be undertaken in order that the new electrification system might be used throughout the main line to Ipswich and its principal branches. In fact, this report was published some ten months before the Southend electrification was opened and the new rolling stock for that line went into service already under sentence. The rapid development in a.c. traction which took place in France and elsewhere between 1951, when the earlier B.T.C. report, "Electrification of Railways," declared in favour of 1500V d.c. for future electrification, and 1956 has been recorded in our pages, and it was as "an investment for the future" that we welcomed the Commission's revised decision in our March 16, 1956, issue.

The fear that all the existing fixed installations on the routes to be converted will be scrapped and replaced is exaggerated, for we understand that the majority of the existing overhead structures will be retained, and that to a considerable extent the present catenaries will remain in use, at least on the lower voltage (6·25kV) section extending through the London suburban area. This type of overhead work is also in position from Stratford to Fenchurch Street, although not regularly used, and has at intervals been energised already at 6·25kV for trial purposes. The conversion of the trains is also being planned so as to avoid wholesale discarding of equipment by keeping intact the present d.c. control gear and traction motors in the motor coaches and feeding them through a transformer and germanium rectifiers on an adjacent vehicle. Modifications on a more general scale will be required in track-circuiting and immunisation of signalling equipment from 50 c/s traction currents, and in telecommunications, but these necessities were accepted when the choice of a.c. traction was made. It is true that there were many misgivings among traction engineers both on the railways and in industry at that time, but they were concerned more with the adoption of a compromise rectifier system of a.c. traction than with the high-voltage a.c. system itself. We have heard some of the more persistent critics admit that if a.c. series motors comparable in all respects with d.c. traction machines could have been used, they would have supported a.c. electrification unreservedly. Progress in semiconductor rectifiers may yet win over some of the waverers by simplifying installations, and if, on the other hand, a new a.c. traction motor is developed, the railways will be in a position to take advantage of it.

One criticism heard of the B.T.C. decision is that it was in favour of a "French" system. Apart from the fact that attempts to use industrial-frequency a.c. date back at least to the first single-phase a.c. electric locomotive in the world—a Swiss design—it is no longer practical to reject an electrification system which might become universal simply because it has originated in, or been developed by, another country. The variety of systems in Europe which is a legacy of such individualism is already posing problems in the through working of locomotives. This year for the first time a traveller from London to Rome via Ostend, Luxembourg, Basle and Chiasso can make all the rail sections of the journey in electric trains, but in doing so he will cross four "electrification frontiers" and his through carriage from Ostend will have been hauled by three fundamentally different types of electric locomotive by the time it reaches Rome.

THE FORTHCOMING T.U.C.

Next week, the ninety-first annual session of the Trades Union Congress is to be held at Blackpool. The agenda indicates that the debates will, as usual, range over a variety of topics and, in the light of decisions taken at the Congress, trade union policy for the ensuing year will be formulated. An item of major importance in the Congress agenda is the presentation of the general council's annual report. That document, of course, gives account of the general council's activities over the past twelve months, activities which are directed to the fulfilment of the declared objectives of the T.U.C., one of which is "generally to improve the economic or social conditions of workers in all parts of the world."

Trade unionism continues to exert considerable influence in the affairs of British industry and, for the most part, the general council reveals in this, its latest annual report, that it is keenly aware of the problems which face all sectors of industry in the world of to-day. We say "for the most part," for, in one or two places in the report, there are indications that the general council would do well to have some second thoughts about matters concerning which it expresses considerable satisfaction. One such example is to be found in the section dealing with production and industrial development, a subject which is of paramount importance to engineers. The general council expresses its conviction that "work opportunities, better conditions and rising

living standards for all depend to a large degree on industry being technologically progressive and on the ability to raise the volume of output and improve the quality of services through more efficient working methods." That, undoubtedly, is a view which is warmly endorsed by enlightened managements as well as trade unionists. In the same section, however, the general council reports on the " undoubted success " of some two-week technical training courses in production subjects which it has held during the year. The subjects dealt with included method study, time study, incentive systems, activity sampling, costings and production control. These training facilities, it is explained, are provided solely in order to help union representatives obtain " a sound appreciation of the range, uses and implications of production, and management techniques and incentive systems and thus to strengthen their negotiating and consultative skills." We must confess that we are left wondering just how sound an appreciation of these important subjects can be gained in the space of two weeks ! Here, certainly, is one matter which the general council will do well to consider again if it is anxious to improve the negotiating abilities of trade union representatives. Whether matters of this nature will figure prominently in the discussions at Blackpool next week remains an open question. What seems far more likely is that they will receive less attention than the forty-hour week, on which eight resolutions have been tabled, and wages, about which three resolutions have been submitted. To use that somewhat hackneyed expression, we can but " wait and see."

A WELCOME TO FOREIGN FIRMS

There are several reasons why a firm well established in its home country may wish to see its products being manufactured elsewhere. It may be possible, for example, to compete in certain markets heavily protected by tariffs and quota arrangements only by making arrangements to manufacture within the protected region. Again, should the currency of the home country be hard, there may be an advantage in starting manufacture in some other land where currency is softer ; and that advantage may override fears that production may prove more costly. Similarly there are several methods by which manufacture abroad can be started. Perhaps the simplest is to license an existing firm in the chosen country to supply the products. But since the firm thus licensed will normally be free to modify and develop the products there is no guarantee that what is actually manufactured will remain more than merely similar to the original product. Alternatively, a closer agreement can be entered upon whereby full working drawings, &c., are supplied. There are endless variations on that theme. But, again, the firm taking up manufacture is likely to modify designs to suit its own productive methods, and the kinds of materials and subsidiary equipment available locally. Lastly, there is the possibility of setting up an entirely new factory in the foreign land and manufacturing there products identical, down to details, with those produced at home. That last course is the one that has been chosen by the Caterpillar Tractor Company of Peoria, U.S.A., whose new factory at Tannochside, near Glasgow, was opened to inspection by many visitors all last week. It is a course that offers certain advantages to customers ; for it permits all the factories of the company to compete amongst themselves, so that a customer can buy an identical article in the way cheapest or most convenient to himself merely by contacting the right factory. Furthermore, there is no need to rely solely upon that factory if spare parts are needed since all such parts, wherever made, are constructed to exactly the same specification as well as to the same drawings.

There are clearly substantial advantages for the customer ; and such advantages attract custom. But, as was revealed on the occasion of our visit to the works last week, there are some disconcerting consequences for the manufacturer. The products of the Caterpillar Company have been developed in design to meet the high productive methods appropriate on the North American Continent. But in the new Tannochside factory output (at least as yet) is insufficiently high to justify the installation of high cost transfer machinery or even of more than a sprinkling of special tools. It is very probable that products just as good as those actually made could be produced more cheaply by redesigning them to suit the existing production methods. But as products must be identical wherever they come from, no such redesign can be contemplated, and the extra cost must just be stomached. What is even more disconcerting is the difficulty of securing, in a country other than the homeland, materials and minor products which meet the firm's specifications. One of the factors, for example, that influenced the company to select a site at Tannochside for its new factory was the readiness of Colvilles, Ltd., to supply steel to its specifications. For supplies of several other things, to the Newcastle plant acquired in 1956 and to the spare parts plant acquired rather earlier at Leicester, as well as to Tannochside, the representatives of the company found themselves running into difficulties. Suppliers of such things as ball bearings and vee belts, for example, proved unexpectedly to have no standard products which could at all closely meet the firm's specifications ; and they had to be convinced that it was essential to do so. In truth, there has been introduced to Britain a kind of engineering that is in some ways new to it. The company makes vehicles, and therefore looks to vehicle makers and to the aeronautical industry for much of the inspiration behind many of its designs. But the vehicles are so large and have to put up with so much and such unpredictably bad treatment that the company is also engaged in a form of heavy engineering. It was that combination which proved new to suppliers. Thus the coming of the Caterpillar Company to this country has not only brought employment to many people in Newcastle and Leicester and now Glasgow; it has also enhanced in certain ways the experience of British engineers. Rather than grumble, as some people seem inclined to do, about American investment in this country, we should surely welcome such a firm to our shores.

" BLUE STREAK " DIMENSIONS

Our readers are, we dare to hope, free from certain lay illusions that the procurement of the D.H. " Blue Streak " medium-range ballistic missile will contribute very materially to the amount of " preparedness for war " available in return for a limited defence vote. We have suggested, too, that an attempt to improve on the performance of the highly refined Douglas " Thor " with the use of the same propulsion system seems likely to lead only to disappointment. It may be, however, that the British weapon will prove less costly for its designed purpose than any American article, thereby justifying the effort put into its development. Even so, engineers may well have been surprised at the revelations at the Paris Salon de l'Aeronautique and the Commonwealth Space Flight Symposium about the size of the vehicle proposed. The propulsion section resembles nothing so much as the first stage of a Martin " Titan " intercontinental ballistic missile. This resemblance, however, stops short of a certain factor that seems rather essential ; for the " Blue Streak " on its transporter-

erector turns out to be some inches too bulky to go into the aircraft that transports the " Titan," the Douglas C-133 " Cargomaster "—although that great aircraft is capable of accepting the pressure hull comprising all the tankage of a Convair " Atlas " intercontinental ballistic missile. It is true that the Royal Air Force, having been denied the benefits of the only weapon system it has ever operated that has offered strategic mobility, the air-portable " Thor," does not possess transports capable of air-lifting even the " Corporal " of the Royal Artillery, but this " economy " is tolerable, we suppose, because our allies can make up for our deficiencies. It is held by certain critics that the policies which led to the design of the single-stage ballistic missile were ill-conceived. What has now been revealed about the dimensions of " Blue Streak " gives them support. The problem of lifting 5 tons of hydrogen peroxide out of the atmosphere, they will be able to suggest, has become less worthy of study than the question as to how the booster will reach suitable launching sites in the next five years.

A LONDON TRANSPORT DOCUMENT

This year, for the first time, an annual review of the work of London Transport, which has for some time been produced primarily for the senior staff of that organisation, is being offered for sale to the public. It covers much the same ground as the annual report, but it is much shorter and more easily digestible. Amongst other matters, the review before us, covering the year 1958, brings out very clearly the effects upon London Transport, immediate and consequent, of the bus strike of that year, which lasted from May 5 to June 20. Soon after the strike ended, only four-fifths of the pre-strike volume of passengers were being brought into central London by road services ; and the permanent fillip given to alternative forms of transport, more especially by motor-cycle, motor-scooter and pedal cycle, is illustrated by the fact that even in November the level of traffic in London Transport road vehicles was still 8 per cent below that ruling before the strike. Despite increasing congestion and the advent of parking meters, there seems also to have been some more or less permanent transfer of passengers to private cars. For, between July, 1956, and July, 1958, private car traffic in the central area increased by 9 per cent. It might well have increased much more ; for the number of licences current in the London Transport area increased by 17 per cent in the same period. But no doubt traffic congestion discouraged owners from using their vehicles in the London area.

Naturally enough, in a London Transport document intended primarily for London Transport staff, the point is argued that the bus is a far more efficient vehicle for passenger transport than the private car. As the review stresses, " a very large number of cars is needed to bring into the central area a relatively small number of people, whereas a very large number of people come in on a relatively small number of buses." The point was emphasised during the bus strike. The number of passenger-carrying vehicles entering the central area in the peak hours of the morning increased by about three-fifths, but the number of people in them was reduced by nearly a half ! As is remarked in the review, " Personal transport during the strike was unable completely to take the place of the public road services." That is all very true. But it is worthwhile quoting some other sentences from the document. " Whilst the generally superior efficiency of the bus as a bulk carrier of passengers compared with other forms of transport by road was confirmed by the experience of the strike, one fact became clearer than ever : London Transport has no monopoly of transport of passengers. If the standard of service or the facilities provided do not satisfy the majority of Londoners at the level of fares charged, some of the public will resort to other means of transport . . ." The trouble with a bus, of course, is that it cannot carry people from door to door as private transport does ; nor can it provide the comfort of the private car. Were London's streets less congested, we believe many more people would desert the buses for private transport ; and since the population of the area served by London Transport is nearly static, the conclusion must be drawn that the shrinkage already apparent in London Transport passenger transport, especially bus transport, will become even more evident as the years pass. For more and more people will own private cars, motor-cycles, scooters, &c. The pressure of road traffic in the London area has already forced the authorities to embark upon a number of quite expensive schemes for road improvements and it is by no means improbable that in the not very distant future the construction of one or more urban motorways will be authorised. London Transport asserts in the document before us, though upon what grounds we are left uncertain, that the cost of the proposed Victoria line tube railway at about £55,000,000, including rolling stock, would be about the same as that of an urban motorway of similar length but that its carrying capacity would be several times greater. But we cannot accept the implication that the schemes are alternatives. The new tube would be solely passenger-carrying, the motorway would carry goods traffic as well. A new tube railway would ease the crowding of passengers on existing lines ; a motorway would ease surface congestion of road traffic of all kinds. Each method of reducing traffic congestion in London should be judged on its own merits.

The Engineer—100 Years Ago (SEPTEMBER 2, 1859)

" Railway Improvement "

" Improvements are going forward in locomotives. Existing stock is being adapted to burning coal ; and on some lines indeed there is such readiness to introduce this means of economy, that no special provisions are made for preventing smoke. The London and North-Western line, on which the whole matter of coal-burning has been managed in a most slovenly manner, is occasionally figuring in the Police-courts under indictments founded upon violations of the Smoke Nuisance Act. The company pays, however, in the shape of fuel charges, much heavier penalties for the ' want of skill of its *employés* ' than any magistrate is likely to inflict. . . .

" In respect of railway carriages, we doubt if there be a company in the kingdom which is making better provision for its passengers of all classes than the Eastern Counties—the much-abused and long-suffering concern whose directors would not at one time allow the cushioned second-classes of some of its neighbours to pass over its line to the palatial establishment at Shoreditch. There is a degree of comfort, luxury, and dead-weight about the new carriages, of which nearly a hundred of the various classes have been built, which is both delightful and dreadful. The Great Northern has made a bolder push in starting a train of carriages in which the first-class have six, and the second-class seven, compartments each, the bodies being about 40 ft. long, and on four wheels only. Experience will show how far the system of long carriages on few wheels is likely to answer. We have considerable faith in it. We knew a case wherein a railway carriage builder, having a stock of passenger carriages to make for a line, strongly urged the adoption of six wheels under each carriage. He carried his point ; but it having so happened that he afterwards took a contract for working the line, his first act was to remove the middle wheels throughout."

Sixth Congress on Large Dams, New York

A CRITICAL REVIEW OF CERTAIN SUBJECTS

By SERGE LELIAVSKY, Ph.D., M.I.C.E., M.Am.Soc.C.E.

No. II—(*Concluded from page* 134, *August* 28)

At the Sixth Congress on Large Dams, which was held in New York in September last year, an unprecedented volume of material was dealt with. It was not possible to give a comprehensive account of all the papers read before the congress and of all the discussions which took place during its sittings. The present article describes a few of the reports submitted to the congress, which the writer found to be particularly interesting and containing the maximum of significant material. The choice is entirely personal ; i.e. the reports dealt with are not supposed to be representative of all the papers read before the congress, their only distinguishing characteristics being that they appeal to the author.

Arch Dam Behaviour

A SECOND, and by no means less important, matter discussed at the congress relates to the observed behaviour of the slender and graceful arch dams which have been built in the countries of Southern Europe during the last decade or so. Here again there were numbers of extremely interesting and authoritative papers read before the congress which, however, cannot be analysed in detail on these pages because of lack of space. Broadly speaking, the main objective of all this effort was to compare the movements and stresses obtained by numerical calculations, reduced scale model-tests, and measurements carried out on the prototype.

In general, all the information collected in the reports presented to the congress on this

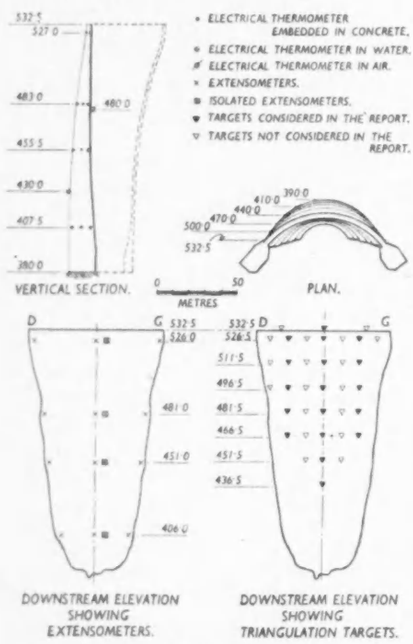


Fig. 11—Santa Giustina dam

point is of unquestionable, solid value. But there are two questions which seem to the present writer of predominant interest. The replies made to them may have a decisive influence on the estimate of the structural safety of this new, light type of structures in the future. These questions are :

A. Granted that the dam undergoes a certain seasonal deformation due to various causes, among which the hydraulic load and the temperature are probably the most important ones, does it return back to its original position at the end of the season ?

B. Does the tensile stress, calculated by some means or other before the work is started, represent indeed the true maximum stress in the actual dam ?

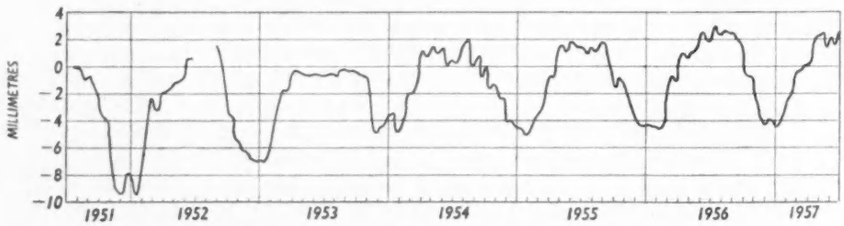


Fig. 12—Santa Giustina dam ; recorded dam movements (crest of top arch)

It may come as a surprise to some that, judging at least by some of the reports submitted to the congress, the reply to both these questions ought to be, No !

That may, of course, seem a very strange answer. But dams of this character have often been observed to have moved bodily in one direction at the end of each season ; and the actually measured tensile stresses are frequently reported to exceed by as much as 200 per cent the values calculated when the project was prepared ! Since this is the observed position the question has to be asked, are then, these dams to be considered safe ?

Before any discussion of individual cases is started, it seems advisable to quote an extract (translated by the writer) from Report 118 (on " Methodes d'Analyse et de Surveillance des Deplacements . . ." by S. Ferry and G. Willm, France). In concluding their paper, these authors say : " The numerous measurements which we have carried out show, that, when observed with great precision, dams cannot be considered as altogether immovable, even after we have eliminated the reversible, periodic movements due to seasonal changes in temperature and water levels. Following the first filling of the reservoir there is generally a period of rather important movement, during which the dam adapts itself to its natural conditions, consequent, very probably, on a gradual evolution in the mechanical and thermal condition of the concrete. But, even after this period, we observe that dams, which are apparently stable, continue moving either abruptly, or slowly, progressively. The origin of such movements is rather obscure. Happily enough, their amplitudes are too small to endanger the structural safety of the works, but their existence shows that these works never cease to 'live,' and that, no doubt, a moment must arrive when they will be affected by their age. When we have kept them under observation throughout all their lives, we shall then be in a better position to appreciate the more or less serious character of the first symptoms of decay." Does, then, this sentence mean that we must stand aside, as impotent onlookers, watching the ageing of a dam and wait till one day or other it chooses to collapse ? The writer thinks that this is too black a picture to paint. There is another way also of visualising the gradual mechanical processes taking place in a dam. It is believed that this alternative approach to the problem may better be explained by means of examples, i.e. by referring to some of the individual papers read before the congress.

As a first instance, we shall take the Santa Giustina dam, built by C. Marcello (Construction Service of the Group Edison, Milano), in the north of Italy ; first because it is one of the highest and slenderest ever constructed and, secondly, because continuous observations extended, in this case, over six complete years, which is a long enough period to enable certain significant conclusions to be drawn.[5] The plan, section and elevation of the dam are shown in Fig. 11. It is 152·5m high, 16·5m thick at the bottom,

[5] See " Analysis of Displacements at Crown of Crest Arch in the Santa Giustina Dam, Measured During the First Six Years of Observations." and " The Behaviour of Santa Giustina Dam During the First Five Years of Observations Compared with the Results of Some Verifying Calculations," Reports Nos. 67 and 68 to the Sixth Congress on Large Dams, presented by the Construction Service of the Group Edison, Milano.

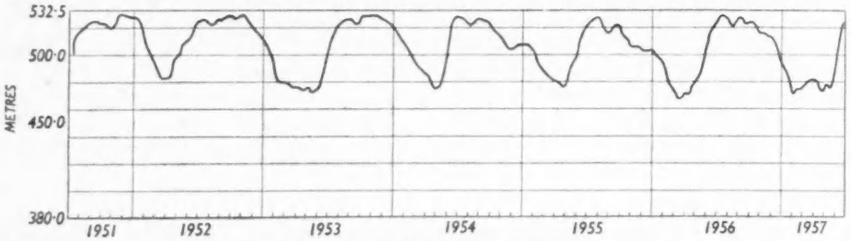


Fig. 13—Water levels at Santa Giustina dam

and 3·5m thick at the top. Symbols represent in this drawing electrical thermometers, placed respectively in concrete, water and air, extensometer rosettes, connected with the dam and with separate blocks, triangulation targets, and other measuring devices.

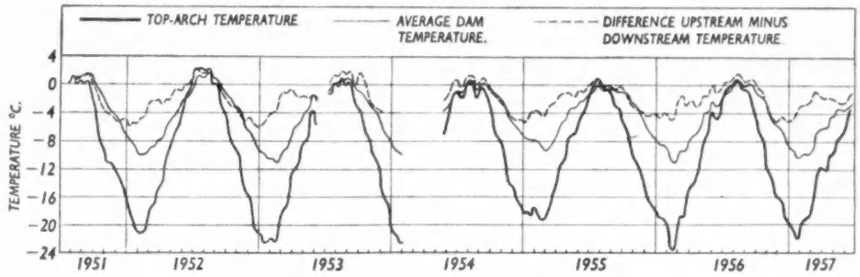


Fig. 14—Santa Giustina dam ; thermal factors

Attention will first be directed to the records of the movement of the crest of the arch,[6] which are reproduced in Fig. 12. In examining this diagram it will be observed that apart from the periodic reversible displacements due to seasonal variations of the water level (as shown in Fig. 13) and temperature (see Fig. 14), there is also a general movement towards the reservoir. Although much less pronounced than the mentioned seasonal effects, this general movement is continuous and must, consequently, be classified as an instance of the progressive movements referred to in the abstract from Messrs. Ferry and Willm paper. There is scarcely any need to insist on the importance of this conclusion, for it is self-evident that, under certain circumstances, the existence of such an uninterrupted movement may be symptomatic of real danger.

In view of this result, it becomes of considerable interest to ascertain whether the true stresses, as measured on the dam by the multitudinous apparatus shown in Fig. 11, do not exceed the calculated maxima, which were thought safe at the time, when the dam was designed and built. Here, however, we are faced with another surprise ; in fact, as seen from Figs. 15 and 16,[7] the horizontal and vertical tensile stresses, near the base of the dam, calculated by four different methods before the dam was built, did not exceed 10kg per square centimetre (9·14 tons per square foot), whereas the recorded tensile stress at the same points after the work was constructed rose to about 30kg per square centimetre (27·42 tons per square foot).

It will be realised that this fact, in combination with what was said earlier about the uninterrupted, continuous movement of the dam, might possibly justify a pessimistic opinion about its safety. It is therefore of much interest to record the manner in which the Italian builders of the dam have resolved the problem. In the first instance, however, it must be explained that the term " recorded tensile stress," as used in the foregoing paragraphs, needs to be seriously qualified ; for the stresses themselves, in this case, as in many other similar instances, are not recorded. What is recorded is the strain, and the stress is then calculated accordingly, using certain assumptions which may (or may not) materially affect the result. This point calls for some more explicit remarks.

In the first instance, it will be observed that the strains were recorded by means of Galileo (from Milano) extensometers, with a base length 80cm and a magnification ratio 250. This was done in four directions at each point. The first correction consisted, then, of deducting from these records the average of the vertical and horizontal strains observed on independent blocks, placed at the same spot. This operation accounted for the local changes in temperature dilatation which did not affect the stress. The second correction was based on the fact that the sum of two perpendicular strains must always be the same, whatever their angle with the horizontal (or vertical). Using the results thus obtained, the stresses in the arches and in the cantilevers were then calculated from

$$\sigma_a = E\frac{\varepsilon_h + \nu\varepsilon_v}{1-\nu^2}$$

and

$$\sigma_m = E\frac{\varepsilon_v + \nu\varepsilon_h}{1-\nu^2}$$

in which ε_h and ε_v were the corrected horizontal and vertical strains, whilst E and ν were, respectively, the assumed values of the Young and Poissons moduli.

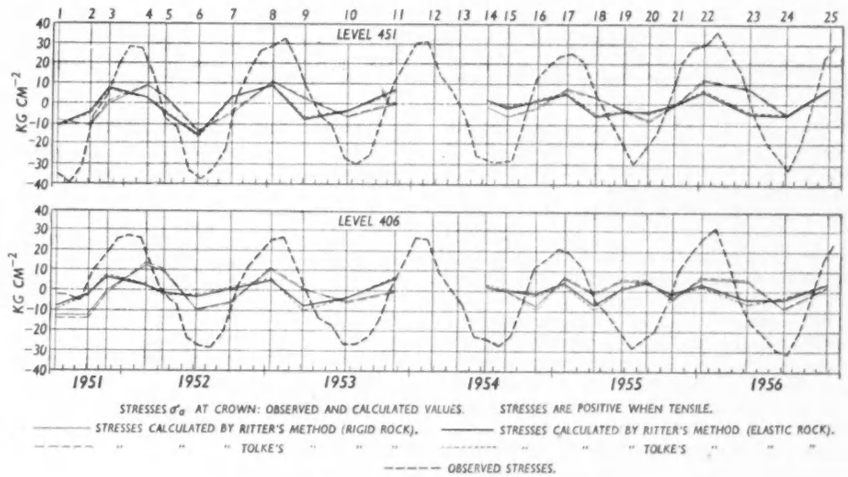


Fig. 15—Santa Giustina dam ; horizontal stresses

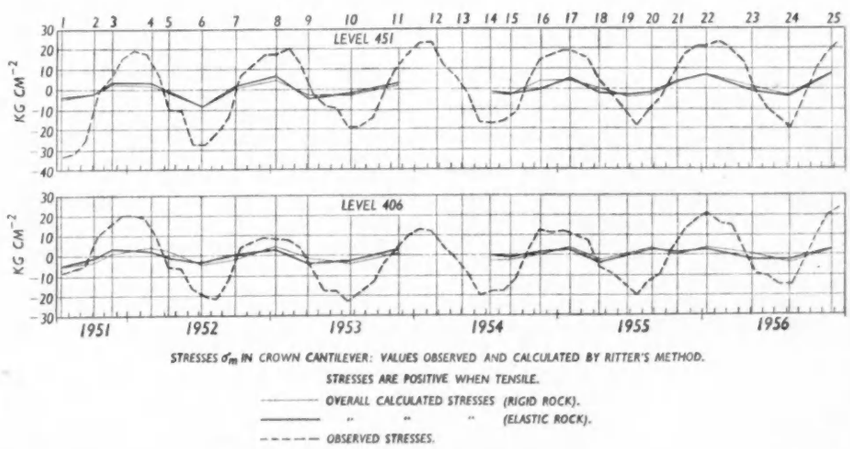


Fig. 16—Santa Giustina dam ; vertical stresses

The reader will thus see that what is frequently colloquially referred to as the " recorded stress " is *de facto* the result of a rather circuitous computation process which, of course, reduces the value of the figure thus obtained as " uncontrovertible evidence." Particularly, since the two coefficients appearing in the relevant equations, whatever precautions are taken in assessing their magnitude, are still assumptions only. In the case under consideration they were taken as E=320,000kg per square centimetre and ν=1/6. Undoubtedly, there were very good reasons for doing so, but suppose, for the sake of argument, that E had been taken equal to 160,000kg per square centimetre—which, after all, is not an altogether unreasonable figure—the " recorded " stress would then have been found half as great as shown in Figs. 15 and 16. Taking into account that the said coefficient varies in time, it appears that one should be rather cautious in interpreting the term " recorded " stress. But even assuming that tensile stresses as high as 30kg per square centimetre do actually exist in the Santa Giustina dam, this fact alone should not be taken as alarming evidence ; for similar (and even higher) stresses exist

[6] Described in the second report mentioned in footnote 5. The relevant figures, which are reproduced on these pages, are abstracted therefrom.

[7] Abstracted from the first paper quoted in footnote 5.

in many other arch dams which all are perfectly strong and safe. The only fact that really follows from the foregoing discussion is that the so-called "calculated" stresses, whether they are obtained by the Ritter or Tölke methods, do not seem to possess much significance.

Thus, the question of the safety of the Santa Giustina dam, as it appears from the reports to the Sixth Congress, focuses basically on the measured movements of its top and it is in this respect that the analysis, as carried out by the staff in charge of the dam, deserves particular attention.[8]

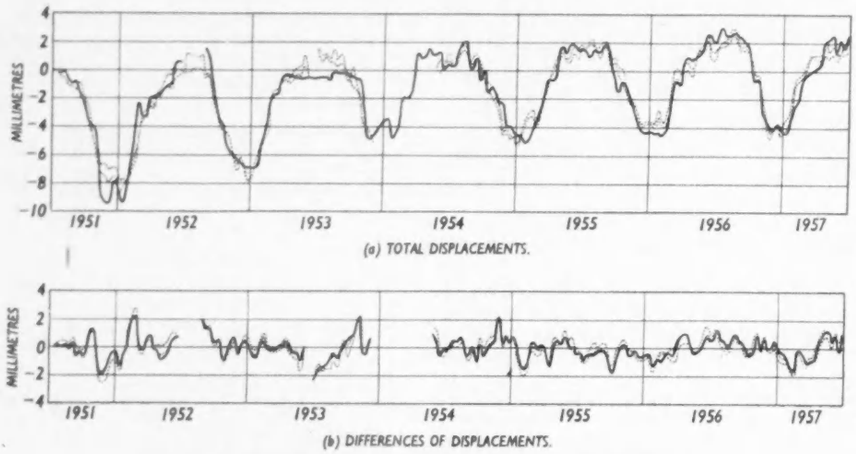


Fig. 17—Santa Giustina dam ; calculated and recorded displacements*

(As it was impossible to reproduce all the curves appearing in Fig. 17 originally, the envelopes only are reproduced. They suffice, however, to show excellent agreement between calculated and observed displacements.—ED., THE E.)

The analysis is based on the following : the movement is assumed *ab initio* to be a function of (*a*) the water level in the reservoir determining the hydrostatic pressure, and (*b*) three thermal factors, i.e. the temperature of the upper arch, the average temperature of the entire dam and the difference between the average upstream and downstream temperatures (which difference is supposed to control the thermal bending effect in the elementary vertical cantilevers). In addition to this, since we detect in Fig. 12 a continuous gradual movement towards the upstream side of the dam, which seems to be a function of time alone, it follows that time, also, must appear as an independent variable in the relevant equations. Hence the basic formula :

$$w = f[\tau, H(\tau), t(\tau), \theta(\tau), D(\tau)]$$

in which

w is the movement of the dam.
f is a function.
τ is the time.
$H(\tau)$ is the water level.
$t(\tau)$ is the temperature of the top arch.
$\theta(\tau)$ is the temperature of the dam.
$D(\tau)$ is the difference of upstream and downstream temperatures.

Note that the whole computation is based on the ten-day means of the observed values, starting from the end of July, 1951.

To facilitate the analysis, it is further assumed that the function f appearing in this formula is the sum of five functions, f_τ, f_H, f_t, f_θ and f_D, each of which depends on one variable only. Thus :

$$w = f_\tau(\tau) + f_H(H) + f_t(t) + f_\theta(\theta) + f_D(D).$$

Now, since all the phenomena appearing in this investigation are regular and continuous, we can assume that all the functions considered are capable of being expressed in the form of series, according to Maclaurin's theorem, and that a certain limited number of terms in each series will suffice as a reasonable approximation. We thus obtain :

$$w = f_\tau(\tau) + \sum_1^{n_H} \alpha_i H^i + \sum_1^{n_t} \beta_i t^i + \sum_1^{n_\theta} \nu_i \theta^i + \sum_1^{n_D} \delta_i D^i \quad . \quad . \quad . \quad . \quad . \quad (1)$$

After several trials, it was found that the first term in this equation can best be represented by the function

$$f_\tau(\tau) = \varepsilon_1 \frac{\tau}{\tau - 74 \cdot 18} + \varepsilon_2 \frac{\tau}{(\tau - 74 \cdot 18)^2} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

in which the time τ is expressed in ten-day units, starting from July 20, 1951, whilst the displacement $f_\tau(\tau)$ is in millimetres.

The problem was thus reduced to finding the number and numerical values of the terms in the four series appearing in equation (1). In this connection four alternative calculations were carried out successively, using complete functions of the first, second, third and fourth degrees, respectively, and in each case the constants α, β, ν, δ and ε were determined in such a manner as to reduce to a minimum the mean quadratic departures between the calculated and observed movements for the 175 ten-day means, representing the period of observations. As is well known, the values of such constants which satisfy these conditions are the roots of simultaneous linear equations of the same number as that of the constants ; viz. in our case, 6 for the first degree solution, 10 for the second degree, 14 for the third degree and 18 for the fourth degree. The results of this analysis are graphically represented in Fig. 17.

In the upper diagram the envelopes of the movements calculated according to the four solutions (dotted lines) are superposed over the actual observations (thick continuous line), while in the lower figure the same computation is repeated for the differences alone, i.e. the graph of recorded results is here taken as being the datum. Note that in addition to the period used for the calculation of the constants, the diagram includes also the first six months of 1957. It will be observed that the coincidence between the calculated and observed curves is very good and that no periodicity whatever can be detected in the diagram of the departures, whichever of the four solutions is used. This result seems to confirm the validity of the method. It also shows that the four solutions investigated are almost equally good ; in fact, the residual mean quadratic departures calculated for these four solutions are, respectively, 0·87mm, 0·80mm, 0·79mm and 0·77mm. It follows that the developed formulas can be used as basis for establishing the cause-to-effect relationships between the several components of the total movement of the dam and the individual factors upon which each of these components depends.

This is done graphically, using the fourth degree formula, as the most accurate one (0·77mm residual error), in Figs. 18 to 20.

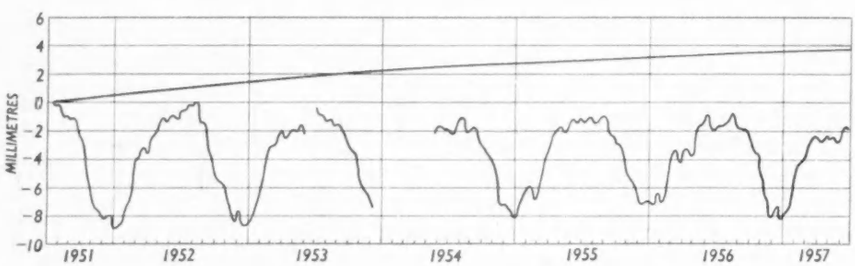


Fig. 18—Santa Giustina dam displacements ; continuous and periodic movements shown separately

Of the greater importance is Fig. 18, which opposes the "continuous" movement of the dam, depending on the time alone, to the sum of all other "reversible" movements, consequent on the effect of seasonal factors (i.e. variable water pressures and temperatures). In fact, it is obvious from this diagram that the "continuous" movement does not by any means increase indefinitely, as it might have appeared to do from the abstract from Messrs. Ferry and Willm's paper, quoted earlier.[9] Very obviously it tends asymptomatically to a limit (about 6mm in the present case) which it never exceeds ; for the rate of this movement gradually diminishes, tending, as it does, to zero.

This approach alters entirely the whole case. Instead of an indefinitely continuing displacement which, as it gradually accumulates, may at some time or other become dangerous, we now have the concept of a perfectly safe structure. Because of a multi-

* Similar computations were also performed for many other dams, for instance, the Gabril dam, in Portugal, see Report 83. Note also that some criticism against this solution was raised during the discussions.

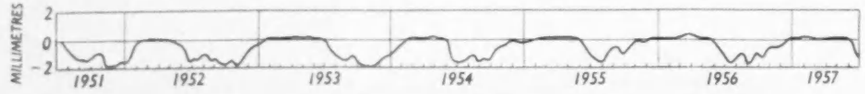


Fig. 19—Santa Giustina dam displacements ; periodic movements due to water pressure alone

* See page 172.

tude of minor local adjustments of the gradually hardening material, this structure needs a few years to settle down but then it becomes stable and basically immovable (except, of course, for the reversible periodic displacements which never cease). This result is fully satisfactory and means that the Santa Giustina dam is by no means less stable and safe than hundreds of other dams and that the only reason why the question of its safety has ever been raised or discussed was that the methods of observation used for recording its movements were of so high a degree of precision that displacements were detected which, owing to their extreme smallness, had seldom (if ever) been observed on earlier works. This, quite naturally, may have created at the start a certain degree of uneasiness, which was, however, completely dispelled when the phenomenon was exhaustively analysed and its true nature made fully obvious.

In this connection it may be rather important to ascertain, whether similar conditions exist in other dams also. Attention is, consequently, called to Fig. 21 which is reproduced from Report 25 on "Present Status of Measurement of Structural Behaviour of Dams in Japan," presented to the Sixth Congress by the Japanese National Committee on Large Dams. The upper curve in this chart gives the upstream water levels at, and the three lower diagrams show the deflections of, the Maruyama dam. As the water level curve shows no clearly defined periodic variations, the seasonal effects appearing in the deflection curves are apparently due to temperature. But the important point, in this case, is that these seasonal effects are obviously superposed, as in the Santa Giustina dam, over a continuous non-reversible movement, and that the rate of this latter movement gradually diminishes in the course of time, tending to approach (but not exceed) a certain limit, i.e. about 12mm to 13mm for the upper curve, 7mm to 9mm for the second curve and about 4mm for the lower curve. This seems to be in full agreement with the behaviour of Santa Giustina dam, with the exception, however, that the direction of the movement is here reversed. In fact, the continuous movement is towards the upstream side at the Santa Giustina dam, and towards the downstream side, in the Maruyama dam.

Attention may also be called to Figs. 22 and 23, although in this case we have strains and not deflections. These diagrams describe observations made on the Pieve di Cadore

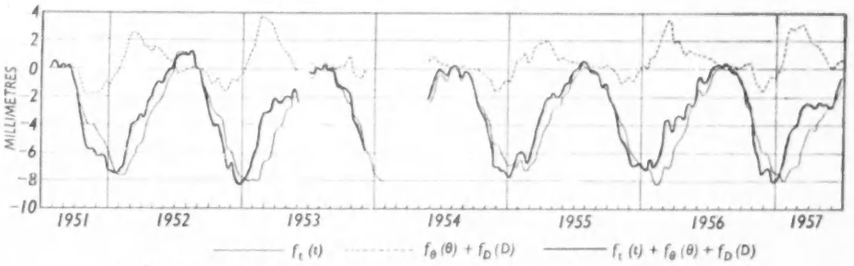
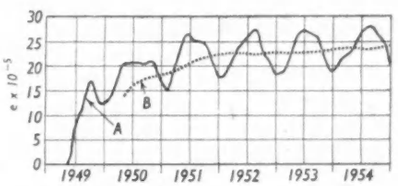


Fig. 20—Santa Giustina dam; periodic movements due to thermal factors alone

dam, in Italy.[10] They show the horizontal and vertical strains measured on the dam; viz. the *A* curve, which gives the monthly averages, including all the seasonal effect, and the *B* curve, which is referred to as the "twelve months mobile averages" and shows the continuously growing, gradually accumulating strain, analogous, in a sense, to the upper curve in Fig. 18. For any given date, this curve yields the average value of the strain, calculated for a twelve-months period, starting six months before this date and ending six months after it. In this manner, all seasonal effects, the period of which is less than twelve months, are auto-

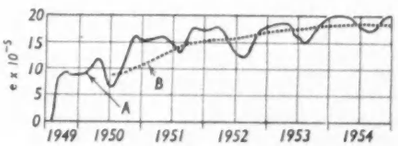


A. Monthly averages.
B. Twelve months' mobile averages.

Fig. 22—Pieve di Cadore dam. Diagrams typical of a set of horizontal strain meters. Monthly and twelve months' mobile averages

matically excluded, and we attain, in this very simple way, one of the main objects of the more involved analysis, which had been done for the Santa Giustina dam.

The main point is that in both cases the continuous effect does not increase indefinitely, but tends asymptotically to a very clearly defined limit. In fact, judging by the curves in Figs. 22 and 23 (which, it should not be forgotten, refer to strains and not to deflections), it looks as though we are faced here with a phenomenon similar to that of the "creep" in pre-stressed concrete structures. This, however, is not so, or not entirely so; for creep takes place always in the same direction—that of the loading—whereas dam movements are rather unpredictable. For instance, we have seen that in the Santa Giustina dam the continuous,



A. Monthly averages.
B. Twelve months' mobile averages.

Fig. 23—Pieve di Cadore dam. Diagrams typical of a set of vertical strain meters. Monthly and twelve months' mobile averages

irreversible movement was directed towards the reservoir, i.e. in a direction opposite to that of the main forces acting on the structure, which should have been the direction of the movement, had it been "creep."

In other cases, the movement of the dam may be directed sideways. For instance, as seen from Fig. 24,[11] the Bouça dam, in Portugal, moved bodily towards the left bank. Owing to general structural symmetry, the movements observed on the model are,

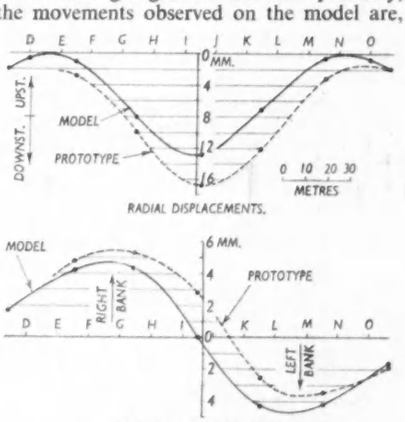


Fig. 24—Bouca dam. Comparison between radial and tangential displacements observed in the prototype and in the model, respectively

obviously, perfectly symmetrical, so that the difference between the two curves in each diagram gives a fair idea of the surprising lack of symmetry in the behaviour of the dam.

What can have been the cause of this asymmetry? The authors of the paper describing the observations suggest that this effect may have been due to the left bank side being subject to greater insolation than the right bank, which of course may be perfectly true, but one should also remember that casting a concrete beam is much easier than building a dam; hence, whilst we may expect

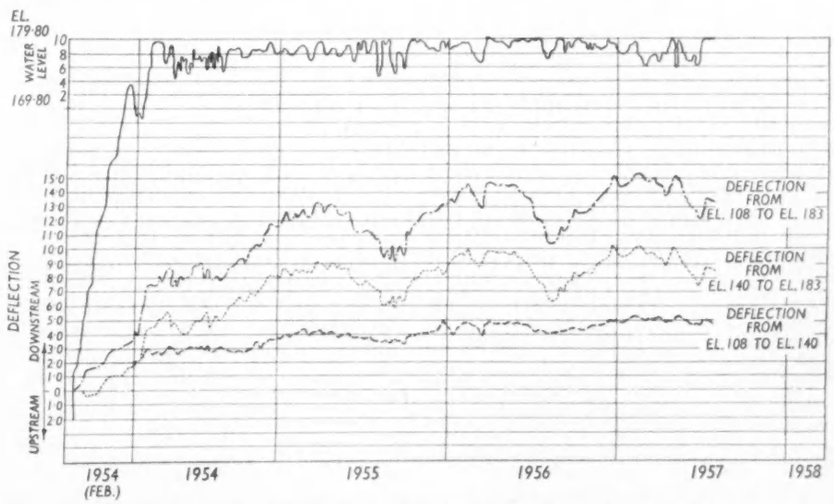


Fig. 21—Maruyama dam. Water levels and deflections measured at block No. 8

[10] As abstracted from Report 75 on "First Experimental Research on the Average Stresses Measured in the Pieve di Cadore Dam and Comparison with the Results Obtained from Calculation and Tests on Model," by Dr. Luigi Rossi Leidi. The dam was built by the Società-Adriatica di Elettricita, Venezia, Dr. Ing. Carlo Semenza, Director.

[11] From Report 84, on "Model Tests and Observations on Bouça Dam," by M. Rocha, J. L. Serafim, A. F. da Silveira and M. E. de Campos e Matos.

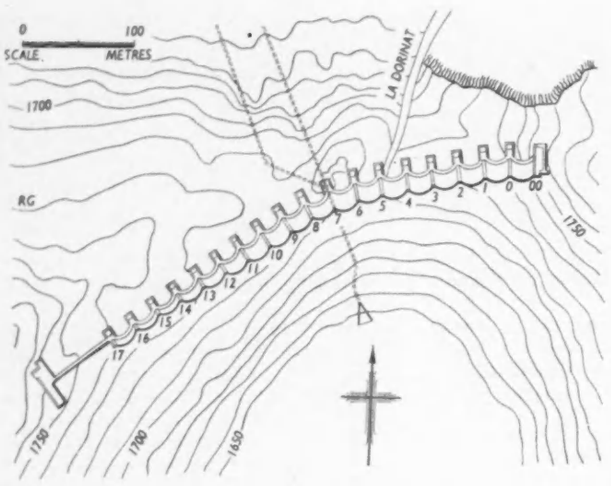
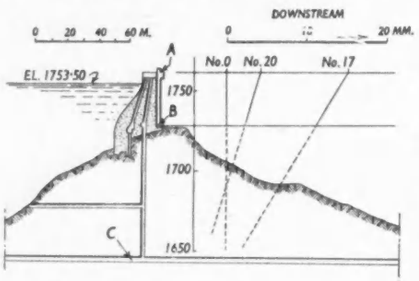


Fig. 25—La Girotte dam ; general plan

the "creep" in a beam to be symmetrical, because of the uniform casting, the same can scarcely be said about the movements of a dam, the building of which may have taken many months, if not years, to complete, and where unavoidable local differences in the execution may therefore be present. In addition, one cannot leave out of consideration the foundations, which do not interfere with the behaviour of a beam, but are known to have materially influenced the movements of certain dams. For instance, at the La Girotte dam, in France,[12] the larger part of the observed displacements at the top of the structure was due to the movement of the foundations. As seen from Figs. 25 and 26, this is a multi-arch structure erected on a saddle, in a rocky valley, and subject, therefore, to particularly intensive foundation movements.

The dam was built as early as 1923, but no foundation trouble was experienced, until it was heightened in 1948. After this, namely, in 1953, heavy leakage was observed to take place, but when remediary measures were taken, the situation returned to what it had been before the heightening. Following these incidents, movement observations began to be carried out, and cover the period of 1954–56. They were made by means of a pendulum, and also by triangulation, which makes it possible to separate the displacements due to the movement of the dam from those of the rock.

In Fig. 27(*a*) we have the water levels in the reservoir, and Figs. 27(*b*) and 27(*c*) show respectively, the total recorded horizontal movement at the top of the dam (triangulation), and the same records less the readings of the pendulum apparatus. It follows, consequently, that the ordinates of Fig. 27(*c*) are the individual displacements of the rock. Comparing the last two figures, we conclude that the part of the movement to be attributed to the deformation of the foundation is, in this case, about three-quarters of the total. To still better bring out the importance of this effect, the ordinates of Fig. 27(*b*) are plotted against the corresponding pendulum readings in Fig. 28. It is obvious from Fig. 28 that a correlation does, indeed, exist between the values represented here, respectively, as abscissæ and ordinates, and that the regression coefficient is about 1/4, the effect of the deformation of the foundation being about three times as great as that of the dam.



A. Topographical bench mark and suspension point of pendulum.
B. Scale for reading pendulum movements.
C. Intake tunnel.

Fig. 26—La Girotte dam. Displacements of pier 7

Further study of these records disclosed the fact of the existence of a lag of about twenty days, between the water level variations in the reservoir and their effect on the rock movements below the dam. This fact is particularly well brought out in Fig. 29, in which the horizontal displacements at the foot of the dam are plotted against the water levels, as corrected to take into account the delayed action effect. Here, again, the existence of a correlation is obvious. Another curious point, which will be made more obvious from the diagram drawn on the right-hand side of Fig. 26, is that La Girotte dam seems to be swinging about a central axis located some 50m to 100m below its footing.

Finally, it is emphasised that foundation movements as important as those recorded at this dam must not be interpreted as a general rule, but are, most certainly, an exception. They are gone into here, however, in some detail, in order to impress upon the reader the fact that under more usual conditions the observed displacement of a dam is probably at least partly affected by foundation behaviour, which, of course, complicates materially the problem as compared with that of the rather elementary case of the deflection of a beam. There are other influences, also, which may tend to magnify the unpredictable, apparently erratic, character of the dam deformation pattern. For instance, such influence may be exerted by the thermal expansion or contraction of the side slopes of the valley itself, in which the arch dam is built.

An example of such an effect is instanced by Professor P. Caloi and Dr. M. C. Spadea[13] in Fig. 30, which is meant to represent the movement (angular) of a voussoir located near the right abutment of the Pieve di Cadore dam in Italy. In analysing the diagram the authors conclude that, during the period of intensive temperature variation, the movements represented in the drawing are controlled by the thermal expansion of the rock, rather than by the thermal expansion and contraction of the material of the dam. This is another significant point to be taken into account in investigating the stresses and deformations in an arch dam.

The next question, in connection with the behaviour of arch dams, is this : do the continuous, irreversible initial movements—such as those we have observed at the Santa Giustina and Maruyama dams—occur in all cases, or are there arch dams subject, from the start, to seasonal, periodic displacements only ? The reply is that the irreversible, uni-directional movement, which usually occurs in the earlier period of the history of

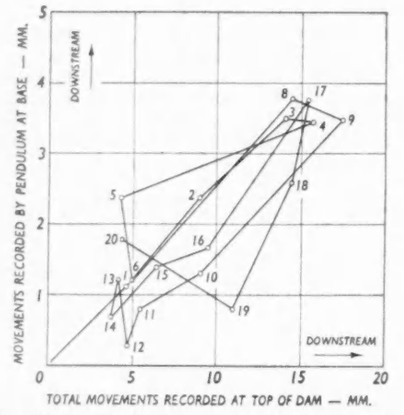


Fig. 28—La Girotte dam. Comparison between total displacement (abscissæ) and individual movements of dam measured with pendulum (ordinates)

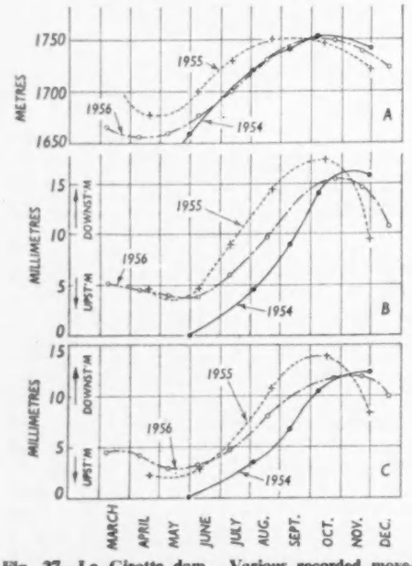


Fig. 27—La Girotte dam. Various recorded movements and corresponding water levels

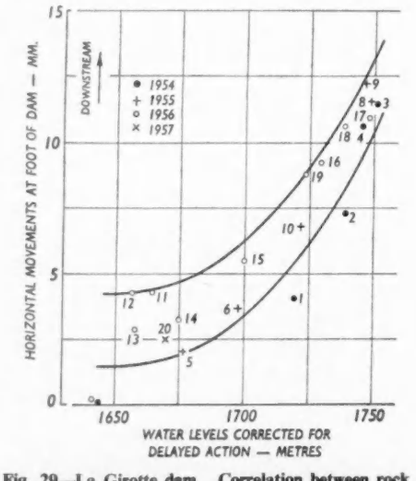


Fig. 29—La Girotte dam. Correlation between rock movements and water levels corrected for delayed action

[12] From Report 80 on "La Girotte Dam—Observation of the Movements of the Rock Seal Supporting the Structure," by Messrs. S. Ferry and G. Willm, of the Electricité de France.

[13] Report 76 on "Geophysical Interpretations of the First Series of Triangulations Carried Out at the Pieve di Cadore Dam."

the dam is by no means general. There are, in fact, some arch dams which are known to have moved periodically from the beginning, i.e. as soon as they were completed, and were subject to the seasonal effects of water pressure and temperature. Such cases, when they do occur, are most probably representative of conditions under which the creep of concrete (if, indeed, it takes place, as a significant factor) is compensated by the various additional effects and circumstances affecting the movement, which means that, in such cases, these various influences may be supposed to neutralise each other.

Whether such are, indeed, the conditions in Fig. 31, which shows the movements of the Isolato arch dam in Italy,[14] or whether this is a case in which the creep is (for some reason or other) ineffective, may be a matter for speculation. The fact, however, remains that, during the early period of its existence, the action of the water level alone, and a first approximation towards a cause to effect relationship may thus be computed. Once such a correlation is provisionally established, the next step is, obviously, to use it in order to exclude the effect of the hydrostatic pressure and thus obtain a curve representing the movements of the (*b*) and (*c*) classes only.

Since the (*c*) class is usually much smaller than (*b*), a "seasonal" diagram is then prepared for a complete year, in which the curves calculated in this manner, for several years, are superimposed upon one another.

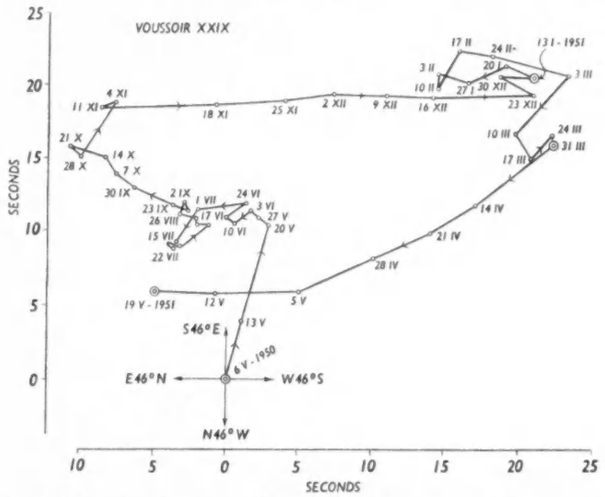
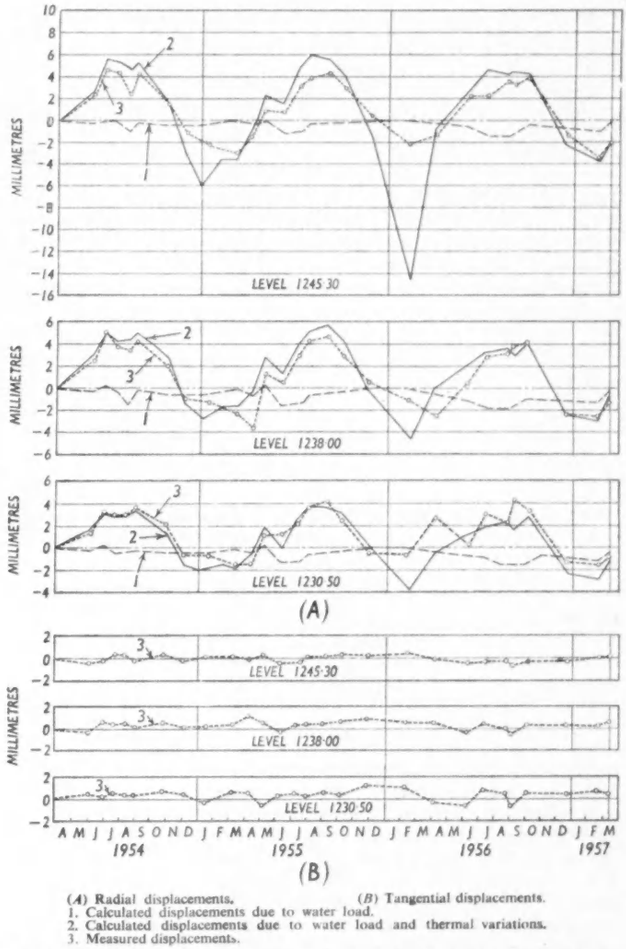


Fig. 30—Pieve di Cadore dam. Recorded angular movements of a voussoir near the right abutment



(*A*) Radial displacements. (*B*) Tangential displacements.
1. Calculated displacements due to water load.
2. Calculated displacements due to water load and thermal variations.
3. Measured displacements.

Fig. 31—Isolato dam. Measured and calculated displacements of targets at crowns of arches. Displacements positive when directed upstream. Tangential displacements positive when directed towards right abutment

the pattern of the movements of this dam was generally cyclic, i.e. at the end of each season the structure returned almost to its original position.

It remains, now, to consider the records and observations of Messrs. Ferry and Willm, which led them to so pessimistic a conclusion (see page 172).

There may be reasons to believe that those conclusions were influenced by the method used for analysing the records, rather than by the records themselves. In fact, whilst the method of analysis applied by the Italian and Portuguese engineers which was described above was essentially analytical, French designers use a graphical solution which, in the author's opinion, may not be altogether free from the personal equation. As the point is of some importance in regard to the problems which are here discussed, it may be of interest to describe the graphical method in question more explicitly.

Dam movements are of three categories : (*a*) those which are due to seasonal water level variations ; (*b*) thermal movements, also seasonal, and (*c*) irreversible movements which are functions of time alone.

In order to separate these three classes of movement, the French engineer concentrates his attention on the periods in which the thermal factors remain (or could approximately be assumed to remain) constant, whilst the water level is rapidly changing. Then the variation of the total displacement during such short periods can be ascribed to

[14] See Communication 14 on "The Isolato Dam During the First Three Years of Observation : Comparison of the Results of Measurements with Some Verifying Calculations," by the Groupe Edison-Milano.

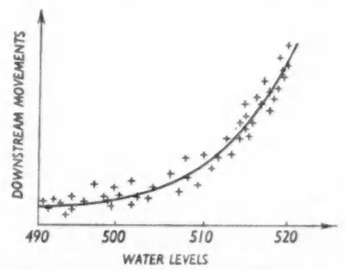


Fig. 32—French method. Corrected diagram showing the effect of water levels

A "cloud" of points is thus obtained which permits, nevertheless, the drawing of an "average" curve, representing average seasonal conditions, in regard to the (*b*) and (*c*) displacements. Subtracting the ordinates of this curve from the corresponding total movements, we obtain a more precise estimate of the effect of the hydraulic pressure on the displacements of the dam, for instance, as shown in Fig. 32 (abstracted from the same report).

With the help of such a curve we can then obtain a set of much more accurate data for the second approximation of the "seasonal" curve referred to in the last paragraph.

Two cases may then occur. The points for several years superimposed on this diagram may form one, single, clearly defined

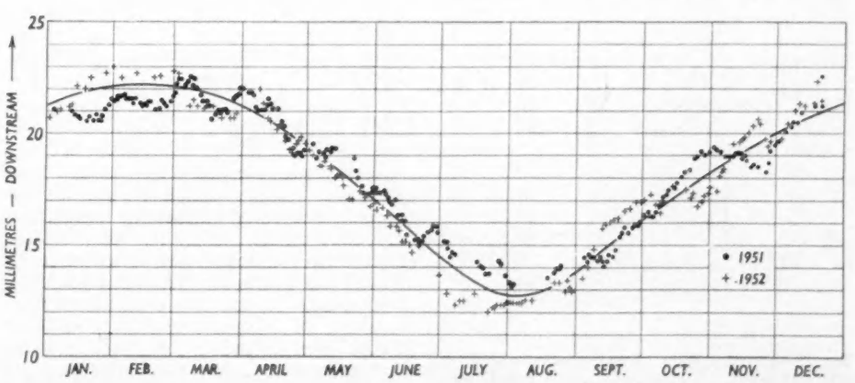


Fig. 33—French method. Saint-Etienne-Cantales dam. Right bank pendulum. Seasonal thermal correction curve

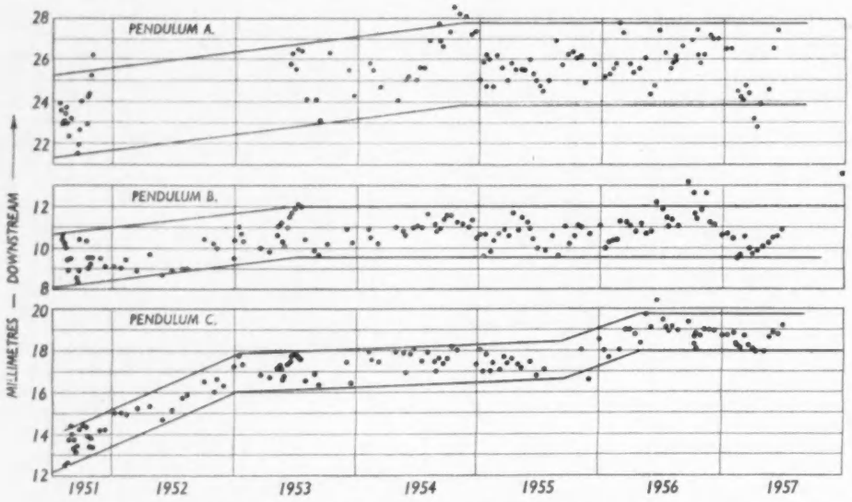


Fig. 34—French method. Chastang dam. Continuous displacements, reduced to constant level and temperature. *A*, *B* and *C* pendulums

curve, in which case we shall conclude that the irreversible (*c*) movements are negligible ; which means to say that in the period investigated the dam was in a stable condition and that the continuous displacement (if any) had either temporarily, or permanently, stopped. Such is the case, for instance, with the "seasonal diagram" for the Saint-Etienne-Cantalès dam appearing in Fig. 33.

In the second case, however, we are supposed to conclude, judging by the general appearance of the seasonal diagram, that the points for the individual years shift. The yearly magnitude of that shift will then supply the information required for the preparation of the continuous-movement diagram, this being the final objective of the method. An example of such a computation is represented in Fig. 34, which shows the continuous movement of the (*c*) class, computed by Messrs. Ferry and Willm for the Chastang dam in France. Better to understand he references appearing in this drawing, to the *A*, *B* and *C* pendulums, attention is called to Fig. 35 which shows the section of this dam with the three pendulums used in this investigation.

It will be clear from the foregoing description that the method under consideration is a graphical computation, based on the trial-and-error principle, the success of which is greatly dependent on the astuteness and subconscious feeling of the computer who uses it. The writer has no doubt that the examples produced in the report are the work of highly trained and competent staff, but as regards generalised conclusions, it is certainly possible to prefer the Italian and Portuguese approach which though possibly objectionable from the purely theoretical standpoint, possesses, nevertheless, the advantage of being free from the personal equation.

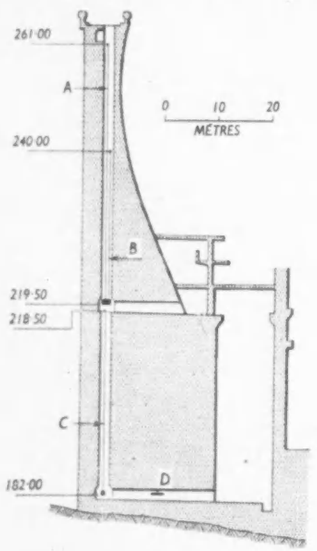


Fig. 35—Chastang dam. Arrangement of pendulums and clinometer. Block No. 3. *A*, *B* and *C* pendulums ; *D*, location of clinometer

For instance, in Fig. 34, it depends entirely on the whim of the computer whether to use polygonal envelopes, such as those actually shown in the drawing, or to replace them by curves of the type appearing in the upper diagram in Fig. 18, which tends asymptotically to a very clearly defined limit. It is true that numerically there is very little difference between the two types of diagrams, but in regard to the general conclusions to be derived therefrom, the difference is of material importance. Because a polygonal pattern, as in Fig. 34, must be interpreted as a number of irregular, haphazard, abrupt movements, whereas a curve, as in Fig. 18, reflects the behaviour of a structure which gradually settles down and becomes, in the course of time, immovable.

Note that we have thus far considered only the envelopes drawn on the last diagram in the French method, but it should be remembered that the points themselves, which appear in this chart, are obtained by a lengthy series of operations, which are also dependent on the personal intuition of the computer. It may, therefore, seem that the difference in the general outlook on the problem of dam movements may, in this case, be chiefly a matter of the methods of analysis used, rather than be the result of inconsistent records.

Model Tests for the Study of Thermal Phenomena in Dams

Reduced-scale model experiments have nowadays become standard practice in various problems of engineering design. In particular, model testing has been widely employed in connection with structural stress analysis and hydraulics. Another new field which heretofore has not been included in the scope of such experiments is that of thermal dam behaviour. It is outlined in two papers read before the Sixth Congress, which, because of the newness of the idea, deserve particular attention. They are : Communication 17, on the "Determination of Thermal Stresses in Arch Dams by Means of Models," by M. Rocha and J. L. Serafim, Portugal, and Report 74, on "A Thermal Study of a Dam by Means of a Model," by L. Massimilla, G. Astarita and A. Gambino, Italy.

To show how new and attractive is the problem, it will be pertinent to explain that the model experiments forming the subject matter of the first of these reports have not yet been started, far less completed. It may, therefore, be a significant point that the authors of this paper believe the matter to be of such great interest that even the preliminary considerations relating to such tests deserve to be presented in a special report to the congress—a point, it should be added, with which the writer of the present article is in full agreement.

The second (Italian) paper gives a complete account of a model test, which has been successfully carried out, and it is this experiment and the various considerations relating thereto, which will form the main subject dealt with in the following pages. In this connection, however, it should be realised that the problems attempted in such tests may belong to two classes :

(*a*) The more comprehensive and ambitious problem including the determination of temperatures, stresses, strains and deformations.

(*b*) A restricted, shortened problem, which includes temperatures alone.

It is this second problem which was dealt with in the experiments of Messrs. Massimilla *et al.* Though, of course, this means that the scope of the information supplied by such tests is materially reduced, the problem remains still by no means an easy one to solve, for its theoretical, analytical treatment, under complicated boundary conditions, may meet with almost insurmountable difficulties.

As is usually the case with model tests, the scale problem dominates the general arrangement of the experimental layout. In this case, three dimensionless numbers are to be kept constant in prototype and model, viz. as follows :—

The Fourier number ... $\alpha t/l^2$

The Nusselt number ... hl/K

and

The Damkölher number $ql^2/K\theta$

in which

q is the heat produced in units of volume and time.
l is the length.
K is the internal conductivity.
h is the external conductivity.
θ is the temperature.
α is the diffusivity, K/cv.
c is the specific heat.
v is the specific weight.

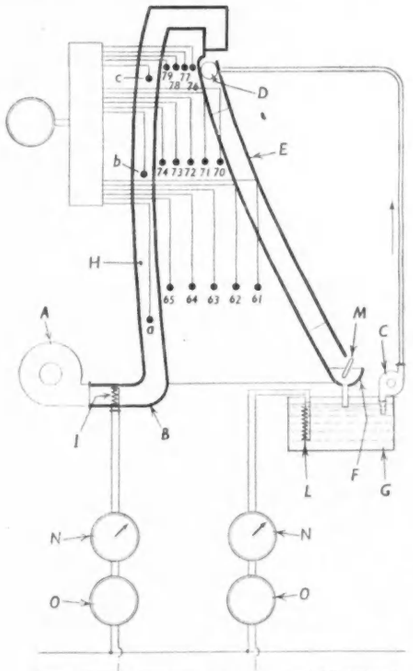
It is self-evident that apart from these three numbers, the law of geometrical similarity must also be strictly adhered to. In which case, the temperatures in the homologous points of prototype and model must be equal, at corresponding times, as determined according to the principle of constant Fourier number. Each of the three quoted constants will now be considered individually, with particular reference to the dam model in question.

Taking, in the first instance, Damkölher's number, it will be observed that it plays a significant part in problems concerned with internal heat generation. It should, consequently, be expected to prove particularly important during the early history of a dam ; in that period, in fact, during which the

hydration heat of the cement causes the temperature of the concrete to rise rapidly, and then gradually to fall. This, however, is not the case. The extremely variegated phenomena occurring during this early period are believed to be too complicated to permit elucidation by means of the model experiment method. In between other considerations, the uncertain value of Young's Modulus, which changes rapidly during this period, precludes the interpretation of the results of a temperature test in terms of stresses.

The experiment under review was, consequently, confined to the study of the temperature variations in the body of the dam, brought about by seasonal changes in the external temperature, after the concrete has cooled down, and the thermal phenomena in the dam have acquired a periodic, repetitive character. The particular profile investigated in this experiment is that of the Pieve di Cadore dam, belonging to the Società Adriatica di Elettricità, for which an exhaustive set of internal and external temperature records is available. Thus the accuracy of the results of the model test can be checked by observations carried out on the prototype. Under such circumstances it was obvious that the Damkölher number could be disregarded in planning the model test in question.

Turning now to the Nusselt number, it will be observed that, in a masonry dam, the external resistance is almost zero on the water face, and is negligible on the air face ; which means that for all practical intents and purposes $h=\infty$. So far as this experiment is concerned, the constancy of the Nusselt number is, consequently, axiomatic. Ergo,



A.—Air fan.
B.—Duct.
C.—Water pump.
D.—Supply pipe.
E.—Supply pipe guides.
F.—Channel.
G.—Water collecting tank.
H.—Corridor.
I.—Electric resistances for air heating.
L.—Bayonet heaters.
M.—Mercury thermometer.
N.—Amperometer.
O.—Variac.

(*a*, *b*, *c*).—Thermocouples for checking air temperature.
(61, 62, 63, 64, 65, 70, 71, 72, 73, 74, 76, 77, 78, 79).—Thermocouples installed in the model. The numbers are the same as those of the corresponding electrothermometers in the prototype.

Fig. 36—Diagram showing experimental apparatus for the study of thermal phenomena in dams

it does not furnish a significant criterion for the design.

Remains the Fourier number, which, indeed, is the predominant consideration. Hence, to ensure similarity, it suffices in this case to satisfy the equation

$$\frac{\alpha t}{l^2}=\frac{\alpha_1 t_1}{l_1^2}$$

in which the symbols α, t and l refer to the prototype, while α_1, t_1 and l_1 are the corresponding values in the model.

This criterion may also be presented in the form

$$\frac{\alpha}{\alpha_1}=\lambda^{2}\tau^{-1}$$

in which λ and τ are the scales for length and time, respectively.

For practical purposes, in order to obtain a generally satisfactory experimental layout, the scale of lengths λ must lie within the

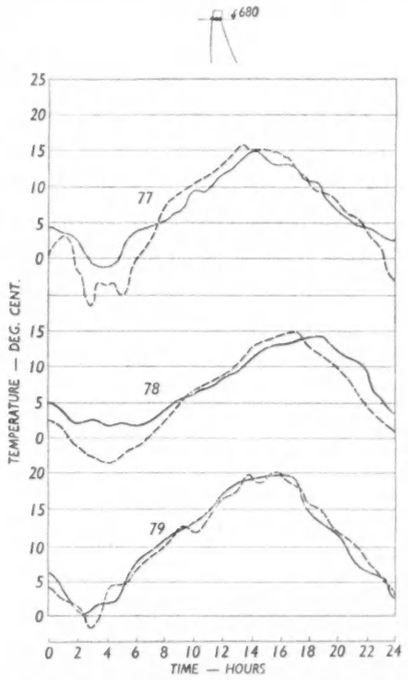


Fig. 37—Temperature-time curves recorded by the thermometers at elevation 680. The dotted curves refer to the electrothermometers in the prototype, the continuous curves to the thermocouples in the model. The numbering of the thermometers is that shown in Fig. 36. The temperatures are measured in degrees Centigrade ; the time—referring to the model—in hours. Two hours in the model correspond to thirty days in the prototype

limits twenty to fifty, and the scale of times τ must not be less than 200, nor greater than 500. Accordingly, the ratio α/α_1, must be chosen between 0·8 and 10. We could, for instance, use for the model the same material as that of the prototype—in this case, concrete—the ratio α/α_1, being then equal to 1·0. However, for various practical considerations, it was considered preferable to abstain from employing a hard material, and the model was made of sawdust, which, as seen from Fig. 36, was kept in position by means of a hard frame, simulating the profile of the dam.

The model was 2m high and the characteristic scales of the experiment were :

Time	... ...	$t/t_1=360$
Length	... ...	$l/l_1=30$
Diffusivity	...	$\alpha/\alpha_1=2\cdot5$

The rigid frame was built of aluminium-

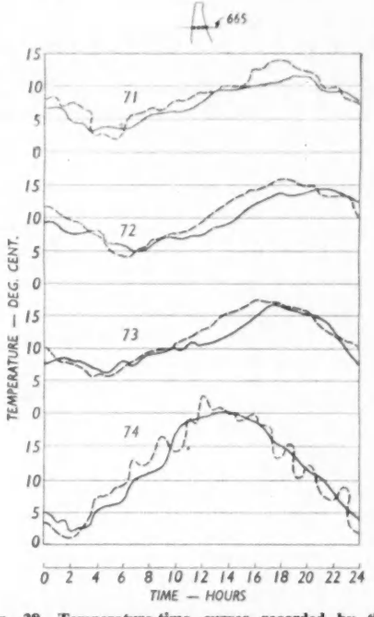


Fig. 38—Temperature-time curves recorded by the thermometers at elevation 665. (See note on Fig. 37.)

lined timber, stiffened by steel ties. Fourteen constantan-copper thermocouples (numbered 61 to 79 in the figure) were placed in the sawdust in such a manner as to reproduce exactly the arrangement of the electric thermometers in the actual dam. A second frame was built all around the model, so as to provide a corridor, into which hot air was blown, thus realising the actual thermal conditions at the dam.

The effect of the reservoir water was simulated by the perforated horizontal pipe *D*, from which water, at the required temperature, was sprinkled over the face of the model, thus soaking the canvas which covered it.

In this manner it was possible to reproduce in the experiment—to the appropriate time scale—the yearly cycle of the external temperature variations, as it was actually observed at the dam. There was, however, another, more difficult problem, which required also to be solved, namely that of the initial internal dam temperature at the beginning of the test. This problem was solved by successive approximations, i.e. the experimental cycle was repeated several times (usually two or three times), until it was observed that the pattern of the internal temperature distribution remained the same at the end of each consecutive cycle. In order to realise in the experiment the temperature corresponding to the winter period at the prototype, the model was placed in a 300 cubic metre refrigerating cell, with a minimum ambient temperature of −8 deg. Cent. In accordance with the adopted scale of time, the yearly cycle at the prototype was simulated by a twenty-four hours cycle in the model.

In Figs. 37 to 39 the temperature diagrams obtained in the experiment for three different levels are superposed over the curves recorded in the prototype. It will be observed that the general agreement between test and prototype is excellent. This conclusion confirms the principle of the experiment and testifies to the fact that similar tests can be used by the designers for estimating the probable temperature-variation cycle in a proposed dam, and thus obtain the magnitude of the thermal stresses, occurring after the concrete has cooled down.

It should be realised, however, that the

layout shown in Fig. 36 is by no means the only manner in which such a test can be carried out. In fact the arrangement suggested in the second paper on the subject, read before the congress (that of Messrs. Rocha and Serafim), is materially different.

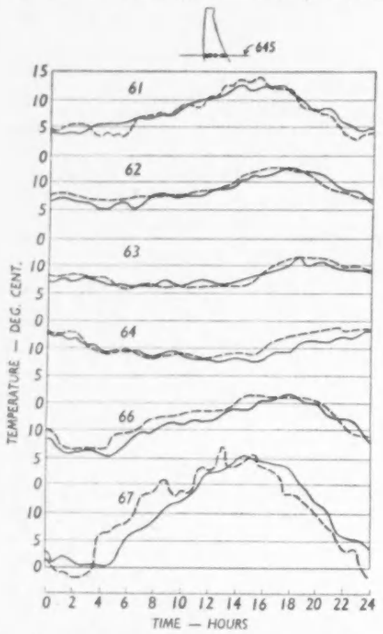
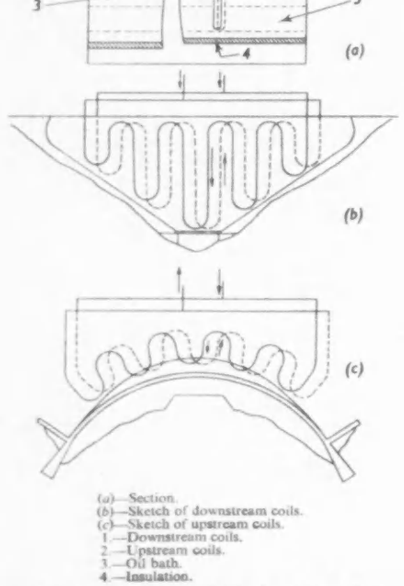


Fig. 39—Temperature-time curves recorded by the thermometers at elevation 645. (See note on Fig. 37.)

In the first place, instead of sawdust which obviously could not be employed to reproduce stresses and strains, these authors intend using a hard material, viz., either bronze, or mortar, or "Perspex" (plastics).

In the second place, instead of the hot-air current, which is employed in Fig. 36 for representing the external temperature variations, it is intended to use one of the following two alternative methods, i.e. either (*a*) a hot oil bath with a system of coils, where hot or cold water can circulate, or (*b*) radiant heating of the faces of the model by means of special infra-red lamps, and cooling them by jets of dry, cold air.



(*a*)—Section.
(*b*)—Sketch of downstream coils.
(*c*)—Sketch of upstream coils.
1.—Downstream coils.
2.—Upstream coils.
3.—Oil bath.
4.—Insulation.

Fig. 40—Sketch of water circulation in coils, for a projected experiment on thermal effects in dams

The (*a*) alternative is schematically illustrated in Fig. 40, which is abstracted from the quoted paper.

It will be observed that on the downstream side of the model, two coils, made of copper pipes 8mm in diameter, are mounted parallel to the face of the dam. Water circulates in them in opposite directions, thus ensuring uniform heating of the oil, from bank to bank of the channel. On the other hand, on the upstream side the coils are arranged in a horizontal plane. The bed of the valley is insulated in order to confine the temperature variations to the dam proper. These and various other precautions are essential to produce the correct effect on the material of the model and to be able to record the result.

Copper-constantan thermo-electric couples will be used to measure the temperatures in the model, while the strains will be recorded by bonded electric resistance gauges. Here, however, another difficulty arises, for such gauges are known to be largely affected by temperature changes. A special technique requires, consequently, to be evolved, based on the comparative calibration principle; in such a manner that in parallel with the gauges fixed to the model, other gauges will be attached, for sake of comparison, to free test pieces, made of the same material. Once the strains are thus found, the stresses will be deduced therefrom, using the known values of the Young Modulus and Poisson's ratio. These are the general lines of the proposed testing equipment. The details, however, require still to be worked out. At the present stage, it is too early to decide on the relative merits of the two tests, the one which is already completed, and the other, which is still in the course of preparation. One point, however, is pretty certain, viz. that experiments of this type will soon develop and become rather popular, and for the next, i.e. seventh, congress, we should expect not only two, but a much larger number of papers dealing with this particularly interesting subject.

Automatic Correction of Microwave Fading

The system described in the following article employs two aerials mounted on one mast at a spacing such that fading does not occur on both simultaneously, and a rotary phase shifter to correct differences in phase. Signals from the two aerials are combined and applied to one receiver. The characteristics of this automatic space diversity equipment have made it possible to combat the difficult transmission conditions caused by the rise and fall of tidal water on a sea-crossing more than sixty-nine miles long.

THE microwave telephone and television link between St. Johns, Newfoundland, and Sydney, Nova Scotia, which was inaugurated on June 18, incorporates a new automatic space diversity system on the "hop" of 69·2 miles across the Cabot Strait. This is believed to be the longest over-water microwave crossing in the world, and diversity reception was necessary to meet the difficult fading conditions liable to be produced by reflections off the water at different heights of tide. The equipment for this 524-mile link was supplied by Standard Telephones and Cables, Ltd., by whom we were recently given facilities for examining components of the space diversity apparatus at the company's North Woolwich factory and are therefore able to amplify the brief report which appeared in our August 21 issue.

Previous diversity systems have generally been based on the principle of selecting the better of two signals from separate aerials and receivers, or of combining receiver outputs at some stage. The new S.T. and C. system, on the other hand, has been designed to achieve similar results while economising in equipment by combining the radio-frequency signals from two aerials and using only one receiver. One aerial is used both for transmission and reception, and the other, or diversity aerial, is for reception only. Both are mounted on the same mast (Fig. 1), and in the Cabot Strait crossing the spacing between them is 30ft on one shore and 15ft on the other, this variation being necessary because of the different elevation of the two sites above sea level. The aerial paraboloids on this difficult section are 14ft in diameter as against 10ft on the rest of the route.

The use of vertically spaced diversity was suggested by experience going as far back as the 17cm telephony and teleprinter link between Lympne and St. Inglevert supplied by S.T. and C. in 1934—the first microwave equipment in commercial service in the world. It was found in operating this scheme that fading varied with the tide and the consequently changing angles of specular reflections from the water. These result in a standing wave pattern in space. By suitably

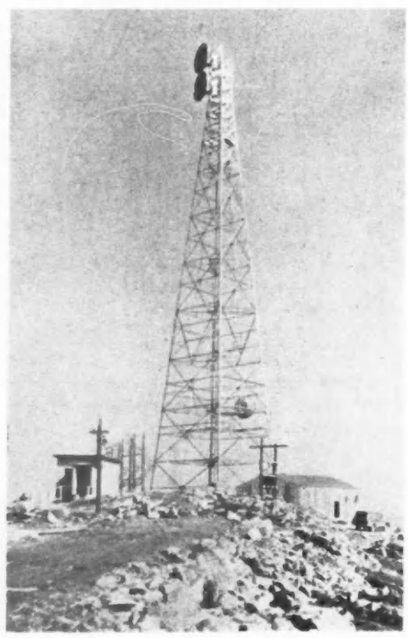


Fig. 1—Repeater station at Red Rocks, Newfoundland, showing paraboloids of main transmitting and receiving aerial (upper) and diversity aerial (lower)

positioning the two aerials on the mast it is possible to ensure that fading does not occur simultaneously on both and to arrange that signals on the two aerials reinforce each other. The diversity system incorporates a servo-operated rotary phase-shifter in one of the aerial waveguide runs. Differences in phase are detected and operate through a feedback loop to drive the phase-shift rotor in the correcting direction.

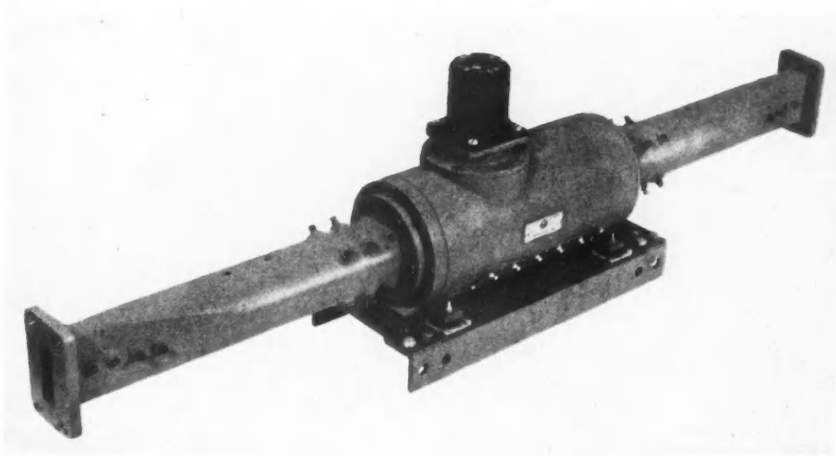


Fig. 2—Rotary phase shifter. Note transitions between rectangular and circular waveguide, and servo-motor for driving the internal rotating cylindrical member

A characteristic of the principle described is that even large amounts of noise have no effect on the operation of the diversity system. Because the phase correction is accomplished by a rotary device, there are no discontinuities or switching transients ; the rotor continuously follows up a changing phase-relationship in either direction.

The rotary phase shifter is seen in Fig. 2. It is mounted between transitions from rectangular to circular waveguide and back to rectangular, and is installed in the apparatus building in the overhead run of waveguide from the lead-in to the top of the rack equipment. The rotating part is a hollow cylinder approximately 9in long and 3in in diameter, in which are mounted two diametrically-opposed rows of susceptance screws. A two-phase servo-motor is bolted to a mounting flange on the circular guide and drives the rotating member through gearing.

As seen in the diagram, Fig. 3, the signal from the diversity aerial is modulated by a ferrite phase modulator, the magnet of which is excited at 35 c/s from an oscillator. In this way a phase " wobble " is produced. If, when the signals from both aerials combine at the hybrid transformer, they are not in phase, a 35 c/s amplitude modulation will be present in the combined signal.

A portion of the i.f. is taken to a crystal detector so that if modulation is present a 35 c/s output is obtained ; this is then applied to a phase-sensitive detector stage in which the modulation is compared against the 35 c/s oscillator signal as a reference. The d.c. output from this stage is positive or negative according to the sign of the phase difference between the main and diversity aerial signals. This is used as the error signal for the servo system and its amplitude is proportional to the extent of the difference.

For convenience in amplification, the d.c. signal is converted to a.c. in a 60 c/s chopper circuit, producing a mains frequency square wave of amplitude and phase depending on the original phase error. This is applied to one winding of the two-phase motor driving the phase-shifter ; since the second winding is supplied through a transformer with mains frequency a.c., the direction of rotation of the motor changes according to whether the d.c. input to the chopper circuit is positive or negative, which in turn reflects phase differences between the main aerial and diversity aerial signals.

The diversity equipment comprising power and meter panels, the 35 c/s oscillator, 70 Mc/s i.f. amplifier and three control units, is housed in a standard cubicle. As in the other repeater and terminal equipments of the link, the rack is a steel framework 6ft 6in high, 22in wide and 20in deep. Electrical connection between the rackside cabling and the apparatus units is made with bridging plugs inserted in adjacent sockets ; thus any unit may be removed from the framework without disturbing other units on the rackside. There are no waveguide components within the rack.

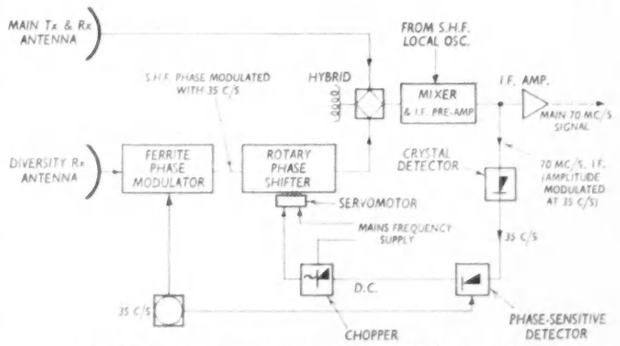


Fig. 3—Servo system for automatic control of phase shifter

All terminal and repeater stations in the link have a standard output of 5 watts. Each aerial can carry three transmit and three receive wideband radio channels, each with a capacity of 600 telephone circuits or television, although initially three channels in one direction and two in the other are being used. With slight modification, the equipment can be made suitable for the transmission of colour television to N.T.S.C. standards when this is required. The Newfoundland system operates in the band 3600 to 4200 Mc/s to conform with the frequency allocation of the Bell TD2 system. Channel separation is 40 Mc/s and the information band-width is of the order of 5 Mc/s. Telephone transmission is by frequency-division multiplex in the band 60 to 2540 kc/s.

Experience with the diversity equipment has been entirely satisfactory. Initial measurements showed that at a time when fading on one aerial was frequently 30 dB or more, the combined signal did not fall more than 15 dB below the free-space level. At times the combined level rose to 6 dB above free-space level, while for about 95 per cent of the total time it did not fall more than 6 dB below it. The speed of response is high, the time constant of the phase-shifter motor being of the order of 0·1 sec., which gives a response speed sufficient to correct for the rates of fading encountered in line-of-sight transmission.

Further automatic space diversity equipment of the type described in this article is being supplied by Standard Telephones and Cables, Ltd., for the overseas paths of new microwave links in course of installation between Folkestone and Lille, and between Carlisle and Belfast.

Automatic Oil Burner Control

AN automatic oil burner control unit for light industrial and domestic purposes now in production by Newman Industries, Ltd., Yate, near Bristol, is the first of a new range of electronic control instruments constructed on a standard plug-in chassis. In the accompanying illustration the chassis is seen fitted into its case and hinged forward on its plug-in mounting for on-site inspection. Alternatively, the chassis may be withdrawn completely and a replacement inserted in a few seconds. The remote photocell receiver head for flame-viewing is designed for fitting into the furnace draught tube and is connected to the control unit by metal-braided cable. A 90CG photo-emissive cell is used and operates in conjunction with a cold cathode valve in the control unit as the switching device for flame failure protection. A red indicator lamp in the control unit cover shows the no-flame lockout condition and is connected to the sub-chassis by a length of flex as shown, so that the cover can be removed sufficiently for inspecting the chassis components without disturbing the lamp. A thermal relay controls the failure-to-ignite time. No thermionic valves are used in the unit. The maker has planned a number of instruments using similar plug-in chassis to bring various automatic control facilities within the reach of the smaller manufacturer.

Oil burner control unit with components mounted on a plug-in chassis common with that of other items in a new range of electronic control apparatus

Maidstone By-Pass

The eastern section of the Maidstone by-pass motorway can be taken as typical amongst the contracts for motorways now in progress in this country. (By contrast the London-Birmingham motorway, which has received more attention in the Press than other schemes, is unique in the size of its contracts and the speed of construction.) The contract for the eastern section covers 5¼ miles of road with interchanges at each end and one intermediate interchange. It includes seven road bridges, one bridge over a railway, one vehicle subway and three pedestrian subways. The road is built partly in the Folkestone sands and partly in the Gault clay. Cuttings are up to 35ft deep, and embankments up to 30ft high, with 1,250,000 cubic yards of excavation altogether.

On sand the construction depth of the road is 16in, comprising a 4in sub-base of clean broken stone, 8in of "wet mix" (premixed waterbound macadam, machine laid and compacted in two courses) and 4in of hot rolled asphalt also laid in two courses. The sub-base extends under the hard shoulder to the side drains. On clay, the construction depth is increased to 25in by an additional 9in layer above the sub-base, which consists of 6in of chalk topped with 3in of flints. No special provision is made to drain this layer. The clay formation was sealed with tar and chippings immediately after excavation.

The UPPER illustration shows a nearly completed section of motorway; the SECOND illustration shows construction of the Chrismill bridge which will carry the motorway over the Maidstone-Dover railway at a 69 deg. skew. This bridge is largely of *in situ* reinforced concrete construction, and will have about an acre of deck. The LOWER view shows one of the bridges carrying a minor road over the motorway nearly completed. Most of the bridges have main beams of precast concrete, precast units up to around 30 tons in weight being used. The appearance of the completed bridges promises to be very attractive.

The eastern section of the Maidstone by-pass is due to be completed by next March. It is being built under the supervision of the county surveyor of Kent County Council. The consulting engineers for the bridges are Messrs. Scott and Wilson, Kirkpatrick and Partners, and the contractor is Richard Costain, Ltd.

Century of Oil

By A. C. HARTLEY, C.B.E., M.I.C.E., M.I.Mech.E.

No. I

THE International Oil Industry has now completed its first 100 years and has for a long time considered August 27, 1859, to have been its birthday because it was on that day that Edwin L. Drake first found oil in Titusville, Pennsylvania, in the first well ever to be drilled for the purpose of finding oil in the United States of America. The industry's products have, during the last 100 years, revolutionised the world's living standards and opened up an entirely new era for mankind, and it is appropriate that THE ENGINEER, although not an oil journal, should take notice of the interplay of the developments in the oil industry and in all branches of engineering which has brought about this remarkable progress. THE ENGINEER completed its own first 100 years in 1956 and the author contributed an article on "Oil and Engineering" to its Centenary Number which dealt with this subject in some detail, but the rapidity with which the oil industry is advancing and increasing its importance in everyday life, warrants further attention.

Some of the earlier history will be retold with reference to the contribution made by engineering developments to the growth of the oil industry and how it, in its turn, has inspired further engineering developments by providing new and improved oil products and by stimulating research and providing an immediate and large-scale market for new engineering materials, methods, plant, machinery and services. Reference will then be made to some of the major developments up to 1956, then to those in the last three years which have been described during the celebrations and to some future trends in order to show the even greater opportunities offered to all branches of engineering as the oil industry embarks on its second century.

EARLY HISTORY

The Centenary of the International Oil Industry is being celebrated this year because of the rapid development which immediately followed the discovery of oil in Drake's well. This rapid development was only possible because the world had been made ready for it by previous successful attempts in Great Britain and in America to replace whale oil which had for more than a century before been the most satisfactory illuminant and lubricant available, but had become very expensive. In Great Britain in 1847, Dr. James Young, a Glasgow chemist, had produced lighting and lubricating oils and an improved material for the manufacture of candles from small oil seepages in a Derbyshire coal mine (this might well have been looked upon as the beginning of the oil industry as we know it to-day), but the seepages were too small for the establishment of a permanent industry and Dr. Young, believing that oil could be produced by distilling coals and shales, studied the artificial production of oil and took out patents in 1850, in which he described processes of distillation and refining by chemical treatments, many of which are in use to-day. Engineers collaborated with him in the establishment of a plant at Bathgate, near Edinburgh, to produce oil from rich Cannell coal and when supplies of this ran out, due to the keen demand for his products at home, on the Continent and to a very large extent in America, they enabled him to develop plant for producing oil products economically from oil shale, which, although cheap and abundant, gave only a small fraction of the yield obtained previously from Cannell coal.

At about the same time, Dr. Abraham Gesner in America, a Canadian physician and geologist, developed a process for making illuminating oil out of bituminous coal and started a refining industry, which also dealt with about 30,000 tons a year of Boghead coal imported from Scotland. There had thus been developed a large market for petroleum illuminating and lubricating oils and refineries had been built for their processing before Drake's well became productive.

There was immediate appreciation of petroleum as a far cheaper material for the production of lamp oil and there was plant available which could readily be adapted to its manufacture. When further oil wells came in, the price of crude oil came down and gave the producers of the finished oils handsome profits and the oil industry was firmly launched. Engineering improvements in the plant used in Scotland led to rapid developments and there were no less than 120 shale works in operation by 1865. Then, however, oil products from the United States, where the developments had been even more rapid, began to compete in the European market, because they were much easier to produce and refine from oil than from oil shale, and the consequent rapid fall in prices led to the abandonment of many of the shale works. Some, however, fortunately survived by applying the closest attention to the development of their processes and using to the full advances in engineering to improve their retorting and refining plant. The old horizontal iron retorts were replaced eventually by batteries of vertical steel refractory lined retorts burning the fixed carbon in the spent shale as fuel and capable of handling 1000 tons of shale a day.

Civil, mechanical and electrical engineering continued to contribute to the full in the development of economical methods of mining, handling, crushing and retorting the shale and in discovering, producing and transporting the crude oil and in refining and marketing the products, thus beginning to pay back the debt they were beginning to owe to the oil industry for providing the better and cheaper fuel and lubricants that were making their own engineering developments possible. The steady and continuing development of the oil shale industry, in spite of all its difficulties, has been of great importance in providing experience for British engineers which has enabled them to play a full part in the rapid development of the international oil industry in all parts of the world during the past 100 years. Within the first ten years of that period, crude oil was being produced in Rumania, Russia, Italy and Canada and by 1900 in Poland, Japan, Germany, India, the Dutch East Indies and Peru. Discoveries in Mexico, the Argentine, Trinidad and Persia had followed by 1911.

After oil has been discovered, its production, transportation and refining involve the establishment of large communities requiring all the public services and amenities and all the industrial facilities of a large provincial town, and in many cases additional special services, such as air conditioning to temper the severe climatic conditions abroad. It is interesting to note that although natural oil was discovered less than a century ago, the annual production in 1900 was 20,000,000 tons; this annual rate has been doubled each decade and it was more than 700 million tons in 1956, and during the last three years has risen to more than 900 million tons. The story of oil is therefore one of great achievement and some of the contributions made by engineers in the various branches of the industry will now be briefly described.

DEVELOPMENTS TO 1956

Oil Exploration.—It is important to realise that unlike coal, which is solid and remains where it is formed, oil is liquid and may migrate considerable distances laterally and vertically, and only provides a prospective oilfield if it is trapped in reservoir rock or sand, sealed in by impermeable cap rock.

The civil engineer was very early on the scene to play his part in oil exploration by surveying, map-reading, road-building and providing means of access and subsistence to enable geological surveys to be made. In recent years, these ground surveys had been greatly helped by air reconnaissance, air photography and photo-geological interpretation. Mechanical and electrical engineers and engineers from many of the newer branches of engineering soon entered the field and are playing an increasing part in contributing the improved methods now used for supplementing the efforts of the geologist and making more certain the location of prospective oilfields. They have assisted geophysicists in the development and use of gravimetric, magnetic, electrical and seismic methods of surveying. These depend upon highly sensitive instruments to measure slight variations in gravitational forces of the earth, in the intensity of the magnetic field, in electrical conductivity and in the velocity of transmission of seismic waves in the earth.

The use of one or more of these geophysical methods often establishes the possible existence of favourable underground conditions, but cannot indicate whether oil has ever been trapped in the structure and, if so, whether it remains there now. The only method of proving an oilfield is by drilling wells, but further developments in geophysics are assisting in the location of test wells so that fewer dry holes are now being drilled.

Oil Well Drilling.—The only equipment available to Drake when he drilled his first well was that normally used for drilling water wells, and it is fortunate that he had only to reach a depth of 69ft. It says much for the pioneers who produced the early drilling rigs, largely from rough-hewn timber, that there were traces of many of their ingenious devices in the design of drilling rigs for the next sixty years or more. Drilling during that period was by the cable tool method, in which a heavy steel bit of the chisel type was suspended by a manila rope in the earlier days and later by steel-wire cable, motion being imparted to it by a crank and beam which utilised the stretch and spring of the rope or cable to produce an impact on the formation somewhat like the cracking of a whip. The chippings were baled out after 5ft or 6ft had been pulverised, and a good day's progress was usually of the order of 15ft to 25ft if the going were good. Mechanical engineering developments just before the turn of the century led to the adoption of

the rotary, or mud flush, system of drilling and real progress began to be made. This system, as its name implies, depends upon the more orthodox method of rotating a bit of special design which cuts the formation with a combination of a cutting and paring action imparted by the cutter wheels revolving in the bit head. The bit is connected to screwed drill pipe rotated at surface by a special rotary table, a continuous flow of mud being pumped down the drill pipe and up the annular space, cooling and lubricating the bit and bringing the cuttings to the surface. The mud is loaded with barytes and other materials to specific gravities of 1·25 or more in order to counterbalance the pressure of the oil in the formation and to prevent the oil gushing to the surface when the well is drilled.

A special hydraulic packing gear has been devised to enable drilling to be carried out under pressure, and it is used in the case of very deep wells where the weight of mud alone would not counterbalance the oil pressure. It has been necessary to develop throughout the years improved drilling techniques to enable ever deeper wells to be drilled and deeper oilfields to be discovered. At these depths, higher pressures are encountered, and reservoirs having rock pressures of more than 6000 lb per square inch can now be explored without difficulty. The very special problem of drilling 3 miles or more below the surface called for a highly specialised design of casing, drill pipe, rotary tables and particularly of lifting gear, which is the key to the operation. The necessity for very rapid hoisting speeds, so that the drill pipe can be drawn from the hole for changing bits and lowered again with the minimum loss of time, has produced a special design of hoisting gear which has no equal in any other branch of mechanical engineering. The handling of high pressures, both in mud, oil and gas, calls for very special designs in valves and surface fittings, as well as in oil well casing.

The requirements of the international oil industry have led to the development of special types of steel in order to produce the toughness and high tensile qualities required at these great depths, where dimensions permit of only the minimum factors of safety. Steam was used extensively in the early days of drilling to drive the draw-works, rotary table and mud pumps, and it is still the most satisfactory power because of its flexibility. It cannot, however, be used economically in oilfields where water is extremely scarce or unsuitable for boilers. In such conditions, the internal combustion engine and electric motor drives have been increasingly used. The necessary flexibility to enable steady pulls to be maintained by the draw-works on the drill pipe and steady pressure on the mud, &c., has been obtained by fitting hydraulic couplings. Drilling by electric motors has usually been adopted where a large number of wells have had to be drilled in a fairly restricted area and where it has been possible to obtain sufficient electric power.

The depth of the early wells was rarely more than 3000ft, but wells were regularly drilled to 17,000ft, and in some cases even to more than 20,000ft by 1956.

The industry has used each advance in the design of new tools for fishing in case of "twists off" of drill pipe, of new methods of coring and of testing wells. Production in tight formations has been increased by shooting and by acid treatments. More recently, methods of electrical logging have been used to survey wells before the casing is lowered and have provided valuable geological information, and in many cases have done away with the need to core and have greatly speeded up operations.

Oil Production.—In the early low-pressure oilfields, relatively small quantities of gas came out of solution when the oil was reduced to atmospheric pressure, and this gas separation could be allowed to take place in tanks working at atmospheric pressures with very little effect on the quality of the crude. In the deeper oilfields now being produced, the pressure of the crude oil in the reservoir may exceed 5000 lb per square inch, and flowing pressures at the top of the well may be more than 3000 lb per square inch. Natural petroleum gas in proportions varying from 2000 : 1 to 4000 : 1 by volume is dissolved in the oil. If these high pressures were released in a single stage, large quantities of light oil fractions, of great value as a constituent of petrol, would be carried away with the gas. The flow of oil is therefore directed, after a preliminary separation of the leanest gas at the well head, to a series of heavy steel separators, each being at a lower pressure than the one before and ranging from about 1500 lb to 15 lb per square inch. The gas is taken off at each stage, and the crude oil is then delivered to flow tanks, from which it is pumped down pipelines to the refinery or to the crude oil loading terminal. The gas is used as far as possible in the oilfields and in the pumping stations and refineries and is processed for production of special products.

Crude Oil Transportation.—Oilfields are usually found a considerable distance from the refinery or crude oil loading terminal site, which must necessarily be alongside deep water to enable products and crude oil to be loaded into ocean-going tankers for delivery to the world's markets. Oil was for many years transported from the wells in oak barrels, but proposals were made as early as 1861 for a wooden pipeline, 4in in diameter and 6 miles long. The first successful line was made of cast iron pipe, 2in in diameter, with screwed joints. It, too, was 6 miles long, and had steam-driven pumps which delivered about 70,000 gallons of oil a day. Further lines were built during the next year or two, and by 1878 a 6in line, 125 miles long, had been built across the Alleghany Mountains. By 1910, about 20,000 miles of line were in operation, and this was increased to 70,000 by 1920, and to 112,000 by 1930. The use of cast iron pipe was replaced by lap-welded steel pipe, and later by seamless steel pipe. Diameters had been increased to 16in by 1939, and screwed joints had been replaced by welded joints, first with swelled ends and inner rings, and later by plain butt joints.

Problems of expansion and contraction had quickly asserted themselves in the earliest days, and lines buried in the ditch during the hot summer weather suffered from pulled-out joints in the next cold weather. Similarly, lines laid in shallow ditches in cold weather expanded and threw themselves out of the ditch in the next hot weather. These difficulties were overcome by crowding an excess of pipe into the ditch with sufficient cover to hold the pipe in position, but serious corrosion problems were the next difficulty. An extra thickness of steel was first used as a corrosion allowance, but this only postponed the trouble. Methods of pickling, priming, wrapping and enamelling the pipe were then developed to provide protection against corrosion, and means have been devised for testing the soundness of this protection.

The alternative method of laying and supporting lines above ground has been successfully used in Iran, where there is no atmospheric corrosion. There was first a tendency for lengths of some miles to move in one direction under the influence of the daily expansion and contraction due to the variation of 100 deg. Fah. in day and night temperatures, but this was overcome by making a sharp bend in the pipe of a few degrees alternately in each direction every 70 yards or so, thus zig-zagging the pipe across country.

During the 1939–45 war, a 24in pipeline, 1352 miles long, with twenty-six pumping stations, was built in America to carry Texas crude oil to the industrial areas of New York and Philadelphia, and this was followed by another pipeline, 20in in diameter and 1475 miles long, for conveying finished products. These lines worked at 700 lb per square inch pressure and were made necessary by the severe losses being inflicted on tankers carrying oil along the Atlantic seaboard, but, apart from these losses, they proved so much more efficient in the use of steel, power and men than tankers, that they quickly led to proposals for more large-diameter lines. Every inch in diameter of line gives an appreciable reduction in capital and operating costs, but brings new problems to the mechanical engineer to solve. Seamless pipe cannot be made at present in diameters larger than 26in, and there is great difficulty in maintaining reasonably uniform wall thickness. Pipe of uniform wall thickness has been made for many years by rolling single steel plates in the form of a circle and then fusion welding the longitudinal seam. The pipe is then subjected to a hydraulic pressure sufficient to stress the steel beyond its yield point and expand the pipe into a die. The pipe is thus made truly circular and straight, and the yield point of the steel is raised.

The oil industry, and particularly that part of it laying gas lines, has been quick to take advantage of the higher permissible working pressures of this type of pipe by reducing the wall thickness and making great savings in steel. This fusion weld process involves the use of very heavy plant which limits the diameter of the pipe produced to about 26in, and engineers have made a valuable contribution to the oil industry by adapting the submerged-arc welding process for the reliable production of welded and expanded pipe of up to 36in diameter. This increase in diameter has enabled great savings to be made in the capital and operating costs of pipelines and has led to the construction of the 30in diameter Trans-Arabian pipeline, 1000 miles in length, from the Persian Gulf to the Mediterranean, the 30in, 32in Iraq Petroleum Company's line from Kirkuk to Banias, also on the Mediterranean, and many large-diameter lines in North and South America and in Canada, notably the Trans-Mountain pipeline, more than 700 miles long, from the Alberta oilfields to Vancouver.

The oil industry has encouraged the development of specialised earth-moving, ditching and back-filling machines for preparing the right of way and the trenches, and side boom tractors, cleaning and priming and wrapping machines for handling and protecting the pipe against corrosion. Civil and mechanical engineers have made great contributions to these developments, and more recently electrical engineers have contributed to the development of cathodic protection, which is now almost always applied to pipelines to deal with the inevitable faults or damage to coatings called "holidays." In this method, current is drained from the pipelines either by coupling them to magnesium anodes or, when an electric supply is available, by using transformers and rectifiers and ground beds. Experience

has shown that, when correctly applied, complete protection can be given to pipelines even when considerable damage has been suffered by the coating, but in these cases it is at the expense of increased consumption of anode or current.

Reciprocating pumps of the duplex and triplex double-acting ram type were almost universally used for oil pipelines operating at pressures of 600–800 lb per square inch in the earlier days, and were driven by steam, compression-ignition engines or electric motors according to circumstances. In 1916, multi-stage centrifugal pumps driven by steam turbines were installed in the Persian pipelines and proved to be very flexible and capable of running very long periods without shut-down. In the case of desert lines where water is not available, centrifugal pumps have been driven by compression-ignition engines through speed-up gears, and heat-exchangers have been installed to enable the circulating water of the engine to be cooled by the oil which is being pumped. In the early centrifugal pump installations, each pump operated in parallel, developing the full line pressure, but more recently, pumps have been arranged in series so that the full throughput passes through each pump in turn and each adds its proportion to the full pressure. More efficient, flexible and simpler installations have thus been achieved.

The pipelines deliver oil to storage tanks in the refinery or the crude oil terminal tank farms, where all-welded steel tanks are now the common practice. They are usually of 10,000 to 16,000 tons capacity, but some of more than 20,000 tons capacity are now being built. These are 168ft in diameter and 48ft in height. They are usually surrounded by bunds capable of containing the oil should the tank be damaged. Fixed roofs are used for heavy, non-volatile oils, but steel roofs floating on the oil are now used for crude oil and for light oils in order to reduce loss by evaporation and to reduce fire risk. Great care is now taken to earth all parts of the tanks and protect them against lightning. Cathodic protection is frequently applied to prevent corrosion of the tank bottoms, and tanks are carefully insulated from the pipelines to prevent increased corrosion if they should become anodic to the pipeline system. The pipelines so far referred to have been for handling crude oil, and pipelines for supplying finished refinery products to the marketing depots will now be described.

Refined Products Transportation.—Pipelines for refinery products have been developed chiefly in the United States, where refined products are handled in larger quantities than elsewhere, and there are now 25,000 miles of products lines in operation. At first, a different line was used for each product, but during recent years it has become almost universal practice to pump aviation and motor gasolene, kerosene, gas oil and light heating oil through a single line, and in some cases butane and propane and heavy fuel oil have also gone through one line. Plugs of water or mechanical separators were at first put between the different products, but experience has shown that provided the velocity of the oil in the pipe is kept well into the turbulent region, and if the sequence of products is carefully chosen, the amount of co-mingling is tolerable and products can be kept to specification when delivered to the depots. Inhibitors, either water- or, more recently, oil-soluble, are introduced into the line at the first pumping station and their amount is regulated to prevent corrosion inside the line. It has been found that the friction factor of the line can be kept low by these means. Facilities are always provided for running scrapers through the line.

Products pipelines of diameters from 6in to 20in or more have been installed and they are operated at pressures of up to 1000 lb or 1200 lb per square inch, chiefly by centrifugal pumps. These are almost always designed for series pumping in each station, and the lines are operated throughout from the initial station, through the boosting stations as a closed or tight system, without the product going in and out of tanks. Reliable displacement meters have now been produced commercially and are used wherever oil is put into or taken out of the system. Provision is made for the regular checking and calibrating of the meters under the working conditions of temperature and pressure, and the passage of the interface between any two products can be accurately forecast to enable the operators to carry out the necessary switching operation at intermediate take-off points and at the terminal into the appropriate tanks.

Standby pumping capacity is installed at the initial station, but frequently not at the intermediate boosting stations, because in series pumping the spare at the initial station can raise the pressure to some extent and help the booster. Electric motor drives are generally preferred where an electricity supply is available, but compression-ignition engines are frequently used with speed-up gears of ratios of up to 10 : 1. Centrifugal pump speeds of 3500 r.p.m. are generally used, but in some cases pumps with speeds as high as 5000 r.p.m., taking 2500 h.p., have been installed. There has recently been a tendency towards unattended pumping stations, both electric and engine-driven, and the sequence of starting and shutting-down operations is automatically timed and controlled and is set in motion and monitored by means of telephones and teleprinters hundreds of miles away. During operation, these stations automatically report to the central control room readings of suction and delivery oil pressures, speeds, temperatures, &c., at prearranged intervals.

Products pipelines are almost always buried in order to avoid undue variations of temperature, and therefore of expansion and contraction of the oil, which makes accurate forecasting of the position of the interface more difficult. Where sufficient movement of oil products in one direction is required, bulk pipeline transport has proved to be more economical than rail or road transport, even in average terrain, and much more so in difficult or mountainous country, and many lines are at present under construction or in the design stage. One interesting case is the 10in Trans-Iranian products pipeline built to take Abadan products to Teheran with a first-stage capacity of 1,000,000 tons a year and a second stage with extra pumping stations of 2,000,000 tons a year. This line is more than 600 miles long and crosses difficult mountain ranges at 6200ft elevation, through which at present there are only difficult roads and a single-track railway, whose capacities are urgently needed for general traffic.

During the war, military rather than economic considerations were all-important, and even where the quantities of products required to be moved in one direction were relatively small, pipelines of small diameter were laid to avoid the use of packages or bulk road or rail transport and to ensure regular supplies. Indeed, difficulties in ensuring regular supplies by tins, barrels or jerricans, with losses of more than 50 per cent in extreme cases, led to the laying of pipelines to follow as closely as possible the advance of the armies in North Africa and elsewhere in 1941. These were "Victaulic" jointed steel lines of 4in, 6in, 8in, and 10in diameter laid on the ground, or buried lines with other types of joints. Petrol or diesel engine-driven pumps were installed to boost the oil every 10 or 20 miles or so. The success of these pipelines and the increasing fuel demands of the modern mechanised army led to the requirements stated by Lord Louis Mountbatten in April, 1942, and referred to by the Rt. Hon. Geoffrey Lloyd, Secretary for Petroleum, for a cross-Channel petrol pipeline to supply the Allied armies when the re-invasion of the Continent took place. This involved the laying of two types of 3in pipe which would have been completely uneconomic in peace time, but which eventually supplied 172 million gallons of motor spirit across the Channel with the loss of only 1·1 per cent. These have been fully described elsewhere as "Operation Pluto" (Pipe Line Under The Ocean).

Oil Refining.—Refining is a combination of physical and chemical operations designed to convert crude oil into a series of fractions or cuts and to treat these raw products chemically to remove any undesirable impurities, such as sulphur compounds and unsaturated hydrocarbons. In the early days, separation was achieved by distillation in simple batch stills, which produced a few impure fractions, such as petrol, paraffin and fuel oil. A simple treatment was used to improve the colour and odour, and the products were then marketed. Demands for better products in ever-increasing quantities led to the development of continuous shell still distillations units and later to pipe stills with fractionating columns. These methods produced straight-run motor spirit up to the limit of that naturally available in the crude. In the 1920s, demands arose for a much improved motor spirit, and processes of thermal conversion or cracking were developed. In recent years, further processes, called thermal reforming, catalytic cracking, polymerisation, alkylation and isomerisation, have been developed. These processes enable the proportions and qualities of the various fractions to be adjusted to market requirements. Vast plants requiring power stations, water pumping plants and services on the scale of a large provincial town are required.

Oil Loading.—Until the outbreak of the war, tankers were rarely more than 16,000 tons capacity and required a depth of about 32ft at low water. Since the war the size of tankers had been increased to 32,000 tons or more by 1956. These require a minimum depth at low water of 40ft. Where this depth could be obtained in a river close to a suitable site for a loading terminal, light jetties were generally used to carry the oil loading pipes and more substantial dolphins were constructed against which the tankers could be berthed. In the early development of new fields, where river loading facilities were not available, sea loading lines were pulled from the shore, in some cases to a distance of 2 or 3 miles, to supply tankers moored at buoys where the depth of water was sufficient. These loading lines were, until fairly recently, 10in or 12in in diameter, but greater experience in laying sea lines made it possible to use diameters of 20in or 24in with greatly increased throughput by 1956.

(*To be continued*)

LETTERS AND LITERATURE

Letter to the Editor

We do not hold ourselves responsible for the opinions of our correspondent(s)

COSTS OF BRIDGES AND ELECTRIFICATION

SIR,—You may recall that I am one of the contributors to your correspondence during 1958 on "Railways into Roads." I have been studying your account of the Tancarville Bridge and have made some rough calculations. The bridge is 60 per cent as long as the Forth and Severn bridges authorised in this country, and has the same carrying capacity. Our bridges are estimated to cost £15,000,000 each, for the bridge structure alone. Your article states that "The cost of the bridge itself, excluding ancillary road work, amounts to about Fr.8000 million." This at the present rate of exchange is £5,700,000. It is not clear whether this sum includes the 440m of approach spans on one side of the bridge. Even if these spans are not included in the cost quoted, there appears to be a frightening difference in the cost of civil engineering works in this country compared with France. I am sure that your readers would be interested to have more information regarding the cost of this bridge, and I hope to see some more information in a future issue.

On quite a different subject, I was aghast to read in the *Daily Telegraph* yesterday, page 15, column 4, that the British Transport Commission, having taken ten years to electrify the line between Liverpool Street and Southend, with £10,500,000 of the taxpayers' money, have decided to tear it up again and change it to the French high-voltage system, which, incidentally, was, I believe, in use in France before they started to electrify this line. It is interesting to note that this system, now to be virtually scrapped, cost £70,000 per mile of single track, so that the cost for a four-track line works out at £280,000 a mile, which is considerably above the figure for a full-sized motorway, including the land and all necessary bridges ! When will the British public realise that the high-ups in the B.T.C. are simply playing ducks and drakes with our money !

I very much hope that I may see some comment on this latest example of centralised "planning" in your valuable paper, but I suppose it is dangerous ground for you as the electrical industry must be licking its lips at the prospect not only of this latest scheme, but of converting the Victoria-Dover line when they have completed the present low-voltage system !

D. F. C. VOSPER

Llandovery,
Carmarthenshire,
August 25, 1959.

[There is editorial comment on the subject covered by the latter part of this letter on page 169 of this issue.—ED., THE E.]

Book Reviews

The Structure of Metals : A Modern Conception. Published for the Institution of Metallurgists by Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 25s.

WHILE astronomers have been defining still further macro-space, aided by radio telescopes, modern physical metallurgists have been exploring micro-space with electron microscopes and new mathematical aids to speed their work. This little book, which is small enough to slip easily into one's pocket, will help engineers and metallurgists to follow what the physicists are thinking.

Each year since 1947 the Institution of Metallurgists has held a week-end refresher course, at which many of its senior Fellows have gathered from all corners of the country. Each year four leading authorities have presented to these gatherings a survey of the present state of knowledge in regard to some particular aspect of metallurgy. Originally it was solely for the members of the Institution that their papers were published in book form. Soon it became apparent that the information was too valuable for such limited circulation, and now for the third year running the refresher course lectures have been made available to a wider public. Hence, it comes that the 118 pages of this little book record four papers, which form together a planned course and were presented by their authors at the twelfth of these courses at Eastbourne in 1958.

The first paper was by Professor G. V. Raynor, of the University of Birmingham, on "The Electron Structure of Metals." He dealt with the various developments which have taken place over the past twenty or thirty years on the theoretical side of the electron theory of metals. We now have a picture of a regular array of ions forming the crystal lattice, electrons in each ion, and valency electrons free to wander through the lattice. The second paper was by Dr. J. A. Catterall, of the National Physical Laboratory, Teddington, on "Experimental Aspects of the Electron Theory of Metals." He concludes his paper with the following quotation : "Between the delineation of the Brillouin zone structure and the quantitative explanation of any single property of a real metal lies an expanse of almost uncharted country, and any information which can serve as a guide must be seriously examined." To an engineer who must get on with the job in practice and do something this might seem disappointing. The third paper was by Professor A. G. Quarrell, of the University of Sheffield, on "Dislocations in Metals." Fracture of metal crystals, like the yield, occurs at much lower stresses than predicted by theory. Engineers must risk lives on the practical indications of fractures, so it is to be hoped that mathematicians and physicists will be able to increase the accuracy of their theory. The fourth and last paper was by Dr. J. Nutting, of Cambridge University, on "Seeing Dislocations." He concluded that the purely theoretical approach, from 1933–1956, to the study of dislocations now appears to have come to an end. It seems that all future work on dislocations will involve a direct experimental approach, making use of the techniques which he outlined in his paper.

It would be impossible for anyone to find this information elsewhere, gathered together in such a convenient form. The authors have quoted from more than a dozen different sources of references to publications used by physicists. Indeed, of the sixty-one references given by these four lecturers, none are to the *Transactions* of the Iron and Steel Institute, and only five are from the Institute of Metals. Yet it was from the members of these two Institutes that the Institution of Metallurgists sprang, with a thoroughly metallurgical background. The well-proved metallography of macro-structure and micro-structure, as shown by magnifying glass and high-powered optical photomicrography, is still of great practical importance to users of metals. That is not discussed in these four lectures, which follow the present day fashion for mathematical expression. They point to some ways in which it is hoped that at some future date physics will help still further the users of metals and alloys.

The Manufacture of Iron and Steel : Vol. II, Steel Production. By G. REGINALD BASHFORTH, F.I.M. Second revised edition. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 40s.

WHEN first published in 1951, as a well-illustrated and documented textbook for students and reference book for industrialists, this was the second of two volumes. The first had covered the primary work of iron production, such as the choice of ores from which iron is smelted and the operation of blast furnaces. In this way the author had already carried his subject as far as the methods of producing pig irons, ferro-alloys and wrought iron. In his following volume, of which this book is the subsequently revised second edition, he reviewed the methods of steel production.

The text is easy to read in diffused daylight but the rather glossy surface of the paper seems to cause unpleasant glare from concentrated artificial lighting. The 390 handy sized pages are helpfully illustrated with 156 figures and each of the thirteen chapters is concluded with a list of references, which will be valuable to students who come new to the subject and wish to study it seriously. Older readers may have in mind other preferred references ; for example, one might have expected mention of Sir Henry Bessemer's magnificent autobiography in Chapter 2, which is on the Bessemer process, but it is not mentioned.

The need for a second edition in such a relatively short time is a tribute to the book, and the author has taken the opportunity it offered and included much new material. This has entailed radical redrafting and the author has achieved his object by transferring the whole of the material dealing with fuels, furnaces, refractories and instruments to a third volume, which it is hoped to publish soon. The new edition has gained by the inclusion of a chapter on the fundamental principles of the physical chemistry and thermodynamics of steel making.

For the limited field covered, the book has been brought up to date by the author, who has now been directly connected with the manufacture of iron and steel for the past thirty years. The field is of necessity limited, so engineers should not expect to find in this book references to the low-alloy steels,

stainless steels, and other special alloy steels which are now of importance where resistance to corrosion, oxidation and creep are essential.

The book covers well the production of ordinary steels and that subject is nowadays essential background knowledge for industrialists, engineers and scientists. To all such this book should be most welcome.

Elements of Physical Metallurgy. By ALBERT G. GUY. Addison-Wesley Publishing Company, Inc., 10–15, Chitty Street, London, W.1. Price 9.50 dollars.

THIS businesslike textbook is intended for students of metallurgy who have already had a good schooling in elementary chemistry, physics and mathematics, as is necessary for all metallurgists. An introduction to the theory of dislocation and additional matter on the electron theory have been included in this new and considerably revised second edition. It also includes a new chapter on Phases in Metal Systems and is as up to date as possible, for the author has had entire chapters read critically by twenty-three different persons whose help he acknowledges in the preface. The book will be understood and appreciated by engineers and many other users of metals who will be helped in its study by the sensible contents list and by the index.

No such book can cover in its 528 pages, which are well illustrated with many photographs, photomicrographs and diagrams, the whole of the subject, but the author has faced his problem cleverly. After preliminary chapters, which survey metallurgy, atomic and crystal structures, he deals with phases in metal systems and phase diagrams. From these he proceeds to the physical properties, elasticity, plasticity, corrosion, oxidation and diffusion in metals. The last three of the fourteen chapters into which the book is divided describe recrystallisation, grain growth, age hardening and heat treatment.

The author is Professor of Metallurgical Engineering at Purdue University and obviously keeps in touch with European and Russian work in his field.

Short quotations are printed under the heading of each chapter to weave the reader into the web of science which stretches back, past the alchemists and the camp fires of ancient man, to the huge ball of vapour consisting of iron, silicon, aluminium and other elements that was the nascent earth. These quotations are taken from apposite writings of Bernal, Carlyle, Lucretius, Voight, Bacon, Roozeboom, Steno, Huygens, Dalton, Alexander Pope, Roberts-Austen (misspelt Austin), Biringuccio, Wilm and Samuel Johnson; this seems to indicate a wide comprehensiveness in the author's reading. Perhaps that is why not the least valuable part of this book will be found to be the twelve-page-long appendix on the Literature of Metallurgy; this deserves study by every student of the subject.

Statistical Quality Control. By D. H. W. ALLAN. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 28s.

THIS is an interesting and useful little book (130 pages), designed, according to the author, so that it can be read and understood by a production executive or engineer during a four- or five-hour aeroplane journey. Its purpose is to demonstrate the usefulness in industry of statistical quality control charts and statistical methods of sampling, and not to give detailed instruction in their use, the author's idea being, that having succeeded in interesting his quarry, he can then pass him on to longer and more detailed text books.

Mr. Allan first states what he considers to be the objectives of statistical quality control which he simplifies (and perhaps oversimplifies) to a basic statement that there is always variation in the measured quality of manufactured products, that this variation can be divided into a random element and "assignable causes." The random element if stable can be graphed by the statistical quality control (S Q C) chart, "assignable causes" being shown by movements beyond the control limits.

A chapter on the scope of statistical quality control in an organisation is followed by "Some Elementary Statistical Concepts" which concentrates on an introduction to the frequency distribution, its different forms and characteristics. There then follows a sensible chapter recommending that before any programme of statistical quality control is started it is essential to study process capabilities; and suggestions for making such a study are given. The remainder of the book deals with Statistical Quality Control Charts, Statistical Acceptance Sampling (with, however, too brief a reference to Sequential Sampling), Statistical Methods for Investigation and Experimentation, and Sources of Information. In regard to the last chapter, since the book was written and published in New York, the references are naturally all to material published in the U.S.A. In this country one would suggest that additional sources of information on the statistical quality control and statistical sampling would be the Statistical Advisory Service, Ministry of Supply, Shell-Mex House and the British Productivity Council, 21, Tothill Street, London, S.W.1.

La Commande Electromagnétique et Electronique des Machines-Outils. By A. FOUILLE, J. CANUEL and A. PEUTEMAN. Dunod—Editeur, 92, Rue Bonaparte, Paris, 6e. Price, Fr.3900.

THIS book, now in its second edition, is in effect a manual of electric drive and control practice with particular reference to the types of motor and associated equipment most appropriate to machine tool applications. It is copiously provided with small diagrams, both of circuits and constructional features, and devotes a useful chapter to showing how a manufacturer's wiring scheme can be analysed and its elements identified with the simplified schematics which have gone before. The range of subjects covered is remarkable, including such basic circuitry as the connections for starting, reversing and braking d.c. motors, and a choke-capacitor filter for smoothing rectified current. On the constructional side, the authors have seen fit to show such details as the interior of an electrolytic capacitor and the heater inside the cathode of an indirectly heated valve. The satisfactory explanation of so many diverse items in the space of 332 pages is a testimonial both to the precision of the French language and the authors' powers of compression. The division of the book into electromagnetic and electronic sections is not wholly satisfactory. For example, all servo systems are grouped under "electronics" although they include rotary amplifier devices. The electromagnetic section is concerned mainly with contactor schemes, general switchgear and protective devices, together with a chapter on choosing a motor which might well change places with the account of the Ward Leonard system in earlier pages. Most of the new material added in this edition relates to servo control systems and magnetic amplifiers. A number of drives applied to specific machine tools are described in the last thirty pages of the book, and a penultimate chapter deals with the particular requirements of woodworking machinery and portable tools.

Work Measurement. By Virgil H. Rotroff. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 39s.

THE greater part of this book consists of an account of the mechanics of taking a time study and of deriving standards from the observations. This part is essentially a manual of procedure for a particular system of data processing and fulfils this purpose very well. The chapters dealing with the extraction and use of standard data are particularly comprehensive; as is common in writings on this subject, the examples are taken from the machine-shop. The more controversial stages such as rating and fatigue allowance are the least satisfactorily dealt with.

The author seems reluctant to admit the possibility of controversy and fails to support some of his stronger opinions. For instance, he holds that negotiated standards are "one of the worst evils which can befall a work measurement programme" but fails to give the evidence. Again he condemns "piecework" and advocates the "100 per cent premium plans"—two systems which are identical except in presentation and which can be combined very usefully. Work measurement procedures other than time study receive brief mention, as does method study, apparently as a by-product of work measurement.

The author believes in the near-indispensibility and near-infallibility of work measurement; in both respects he perhaps overstates the case. In view of this it is surprising that two weeks is considered sufficient to train a time study assistant.

Books Received

Non-Destructive Testing. By J. F. Hinsley. Macdonald and Evans, Ltd., 8, John Street, London, W.C.1. Price 75s.

Sun and Shadow at Aswan. By H. Addison. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 18s.

Transistor Circuits. By K. W. Cattermole. Heywood and Co., Ltd., Carlton House, Great Queen Street, London, W.C.2. Price 70s.

Applied Hydrodynamics. By H. R. Vallentine. Butterworths Scientific Publications, 4 and 5, Bell Yard, London, W.C.2. Price 50s.

Practical Ironmaking. By G. D. Elliott and J. A. Bond. The United Steel Companies, Ltd., 17, Westbourne Road, Sheffield, 10. Price 40s.

British Standards Yearbook, 1959. British Standards Institution, British Standards House, 2, Park Street, London, W.1. Price 15s.

Elements of Materials Science. By L. H. van Black. Addison-Wesley Publishing Company, Inc., 10–12, Chitty Street, London, W.1. Price 49s.

Analysis of Linear Systems. By D. K. Cheng. Addison-Wesley Publishing Company, Inc., 10–12, Chitty Street, London, W.1. Price 8.50 dollars.

Advanced Structural Analysis. By S. F. Borg and J. J. Gennaro. D. van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 56s. 6d.

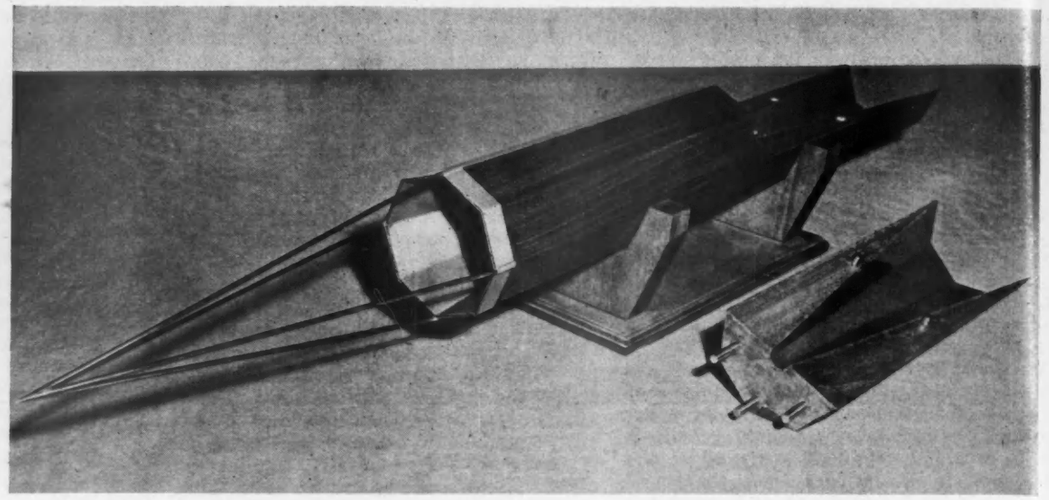
Dictionary of Guided Missiles and Space Flight. Edited by Grayson Merrill. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 131s. 6d.

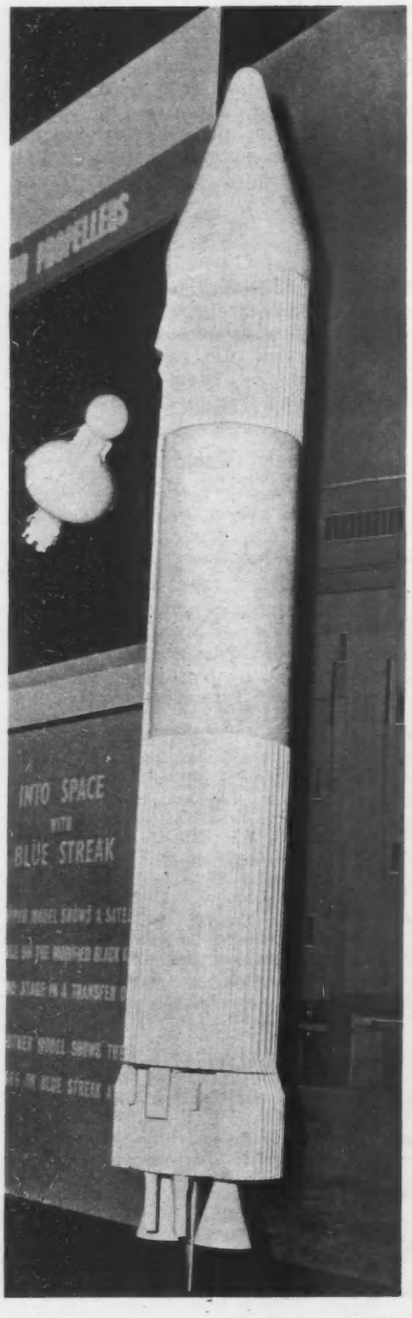
Russian Journal of Inorganic Chemistry: No. 1, January, 1959. Edited by P. L. Robinson. Cleaver-Hume Press, Ltd., 31, Wrights Lane, Kensington, London, W.8. Price 80s.

United States Army in World War Two—The Corps of Engineers: Troops and Equipment. By B. D. Coll, J. E. Keith and H. H. Rosenthal. Office of the Chief of Military History, Department of the Army, Washington, 25, D.C., U.S.A. Price 4.00 dollars.

Commonwealth Spaceflight Symposium

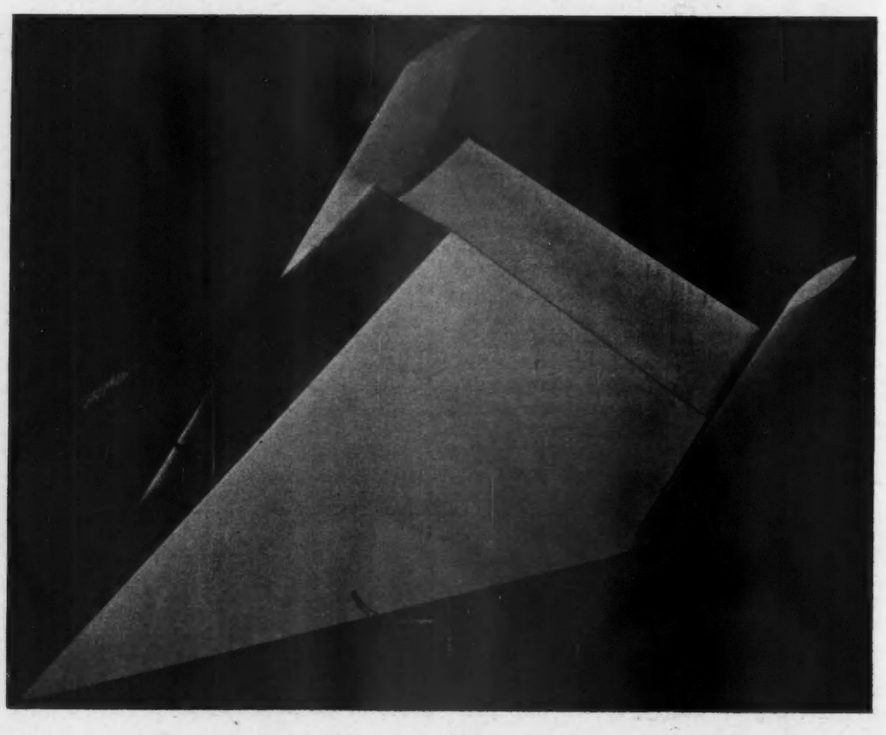
BELOW is seen a model illustrating the use of a de Havilland "Blue Streak" propulsion section as a booster for an orbital vehicle. The vehicle is standard up to the bottom of the upper stiffened section: that section is part of the fairing enclosing the second stage and payload. The second stage is described as a modified "Black Knight," having a "Gamma" II attached to a spherical instead of a cylindrical tank assembly: the 10ft diameter tank is slightly separated from the fairing in order to minimise heating in the boost stage, thus giving rise to the bulge of the model. A model of the satellite is seen in the background: it is suggested that the gross weight of this stage could be 22,000 lb with a mass ratio of 10.





ABOVE is illustrated a hypersonic ramjet proposed by Dr. W. F. Hilton, of the Hawker Siddeley Group. In order to avoid the difficulties of designing a ramjet in which there is subsonic flow, this engine is intended to run at pressures and temperatures high enough to sustain compression ignition of the fuel, which is injected with high lateral velocity at the head of the frame seen outrigged from the intake of the model: the proposal thus has some resemblance to the detonation ramjet, no flameholder being required. The very high pressures that may be involved are contained within, not the walls of the vehicle, but a "box" of shock waves springing from the eight leading edges. Considering only two parallel edges, it can be envisaged that the air will be compressed by each edge in turn, but the deflection imposed by one will be cancelled by the other, so that the resulting velocity is axial. It is further claimed that the fact that each shock springs from a sharp edge and not from a discontinuity submerged in a boundary layer will render the performance more stable and predictable. In theory, the performance does not suffer significantly at incidences up to $^{1}/_{10}^{c}$. A minimum size for such an engine is dictated by the ignition delay, and if this is assumed to be 1 milli-second, an engine designed for M. 7·4 might be 32ft long and 4ft in diameter: at the confluence of the shocks a Mach number of 2·3 would be necessary to avoid subsonic flow of the burnt gas, and the temperature would be 1000 deg. Cent.

BELOW is seen a model of a proposed Armstrong Whitworth recoverable orbital vehicle. It will be recalled that Dr. Hilton's original proposal for a re-entry vehicle employing aerodynamic lift featured a spin-stabilised circular aerofoil. The new design is intended for re-entry velocities of 5 miles rather than 7 miles per second, and is intended to possess much greater control in roll and pitch: it was originated by Mr. T. F. Nonweiler, consultant to the sponsors. The under surface is plane and the upper surface a pyramid, within which a drum-shaped capsule accommodates a crew of two: since the landing speed would be about 80 knots and little choice of impact point would exist, it is expected that the capsule would descend by parachute once the heating phase had been passed. The vehicle would weigh close to 2 tons and be placed into orbit by a three-stage vehicle of 160 tons launching weight: in order that the vehicle shall not apply large asymmetric loads to the launching rocket, an "image" vehicle is fitted to the lower face while the first stage is accelerating it through the atmosphere and then jettisoned. An orbit with an apogee of 700 miles and a perigee of 80 miles is envisaged, and only 17 lb of propellant would be required to initiate re-entry on the next pass: heat liberation during re-entry would gross about 115kW per square foot of wing area, of which all except about 6kW per square foot would be expected to be left in the wake.



Global Aspects of the Exploration of Space

By HUGH L. DRYDEN, Ph.D., Hon.F.R.Ae.S.*

The Commonwealth Spaceflight Symposium on August 27 and 28 was followed this week by the tenth Congress of the International Astronautical Federation, both functions being held at Church House, Westminster. The congress was opened by the Minister of Supply, after which Dr. Dryden presented the inaugural paper reproduced here.

IT is an honour and privilege for me to participate in this congress, a meeting of persons from all the world devoted to the purpose of bringing to accomplishment that which has so long been only a vision of a few gifted men, the exploration of space by mankind. To explore space to gain knowledge of the physical universe in which he lives ; to explore space as a demonstration of his mastery of advanced technology ; to open space to his own travel to satisfy his desire to see and experience for himself ; to explore applications of space technology to improve world-wide communications and weather forecasting—all these aims reflect as in a mirror the desires of men everywhere.

Older Methods of Space Exploration

The interest of man in outer space began long ago among uncivilised peoples to whom the face of the sky was clock and almanac ; the celestial bodies, objects of worship. Exploration was at first by visual observation, later aided by armillary spheres and quadrants, and still later by more precise measuring instruments, telescopes and spectroscopes. The information obtained was that borne by the light that was transmitted from the distant celestial object through the atmosphere to the observing instrument on the ground. In recent years the light waves have been supplemented by radio waves as carriers of information from the stars and planets.

Men of many nations have contributed through the centuries to the exploration of space by the methods of astronomy. The history of advances in astronomical knowledge and technique includes the records of Chinese, Babylonians, Greeks, Arabians, and of nearly every nation of the modern world. International co-operation was early recognised as essential and beneficial ; the countless number of the stars and the vastness of space present mankind with a truly global task.

The picture of the universe obtained by the astronomers early stirred the imagination of men to speculate about the existence of life elsewhere in the universe, about means of communication with distant stars, and in the last centuries about the possibility of the travel of man to the moon and planets. Some sought to apply the science and engineering of their day to describe the vehicles to be used. For example, Jules Verne published in 1865 in *From the Earth to the Moon* a description of a gun-launched projectile carrying passengers to orbit the moon. To-day, we have taken the first steps to bring this inspired vision to reality. The exploration of space by unmanned vehicles carrying scientific apparatus began on October 4, 1957 ; exploration by man will follow in due course.

Space Exploration To-Day

The present stage of development of vehicles for space exploration corresponds to some degree to that of the airplane in 1905. We find it as difficult to predict the pace and scope of developments in space exploration now as it was then to foresee the amazing developments in performance and utility of the airplane which have since come to pass. But there are important differences. In 1905 it was possible for an individual to learn all that had been discovered about aeronautics and aircraft design. Airplanes were designed by individual inventors or engineers. This situation soon changed. To-day, there is no single designer of a modern airplane ; it represents the work of many specialists organised into an effective team and its design is based on the contributions of many men of past and present generations. The development is supported by an extensive research programme in the basic aeronautical sciences. In fact, the development of a modern supersonic airplane is a task commensurate with the technical and financial resources of a whole nation rather than those of a single private company.

I do not foresee any projects in space exploration similar to Lindbergh's flight across the ocean. For the present only a few nations are able to undertake a comprehensive programme of space exploration. There is every indication that the task may soon develop beyond the resources of any single nation. The incentives to international co-operation thus transcend those which led to world-wide collaboration in the exploration of space by astronomical methods. Even at the present stage the global aspects of space exploration demand some degree of international co-operation. I will discuss some of these questions by reference to the programme objectives of the National Aeronautics and Space Administration, a newly established United States governmental agency with the mission of expanding human knowledge of phenomena in the atmosphere and space ; the development, improvement and operation of space vehicles ; and the application of aeronautical and space science and technology to the conduct of peaceful activities within and outside the atmosphere. So far as can be learned, the programmes in other countries include all or some activities of a similar character to those to be described, and the global aspects and opportunities for international co-operation are similar.

Space Science Programme

One of the principal objectives of current space activity is the study of the space environment by the conduct of scientific experiments using apparatus carried by sounding rockets, man-made earth satellites, man-made planets, and deep space probes. In the United States we have used the term " space science " as a shorthand expression for experiments in physics, chemistry, bioscience, astronomy, astrophysics and geophysics which employ instruments transported into the high atmosphere and outer space.

High altitude rocket research began at least as early as 1945. As a part of the programme of the International Geophysical Year many hundreds of sounding rockets were fired by Australian, Canadian, French, Japanese, Soviet, United Kingdom and United States scientists in a co-ordinated global programme. The U.S. and U.S.S.R. together have successfully launched twelve satellites to date, have sent two space probes to become man-made planets of the sun, and have projected two additional probes to distances of 63,000 and 71,000 miles from the earth.

As I have stated elsewhere : " Just as the fullest development of space science involves the whole spectrum of scientific disciplines, so also does it require the interest, support, and participation of the whole world. In the mechanics of conducting a space research programme there is need for international co-operation. The tracking of satellites and space probes and the collection of data from their radio signals provide examples of cases where such co-operation is essential. In scientific research itself there are also many areas in which international co-operation is essential to the fullest realisation of potential scientific gains. Joint efforts in the investigation of the ionosphere and the fundamentals of radio propagation through the upper atmosphere are required to obtain the world-wide coverage that alone can provide a complete picture.

" But most of all, space research needs to draw upon an entire world for its ideas. Those ingenious insights into the real meaning behind a set of observed facts that lead to real advances in the understanding of our universe are not the prerogative of a single nation or group, but come from every quarter of the world where men are seriously occupied with scientific research. So vast is the challenge of space research and so great is the promise to mankind in the way of increased knowledge and ultimate benefits that the world cannot afford to neglect or slight the opportunities that lie before it."

The N.A.S.A. programme for the future, and presumably those of other countries, looks to the orderly development of increased capabilities which permit the more and more detailed study of the space within our solar system and of the moon and planets. Already space probes have been sent to distances beyond the moon and the miss distance will decrease as development of vehicles and guidance proceeds. In due course artificial satellites of the moon will be established, followed by hard and soft landings of scientific equipment on the lunar surface. In similar fashion the nearer planets Mars and Venus will be studied when the requisite vehicle systems are available.

Applications of Earth Satellites

The N.A.S.A. objectives include the investigation of the uses of earth satellites to perform more efficiently and effectively some tasks which are now carried out by other means and to perform other tasks which cannot be done at all with present means. The applications which seem most promising at present are to weather observation, analysis and forecasting on a global scale ; to the improvement of long distance radio communication ; to the study of the size and shape of the earth and of the distribution of land masses and water ; and to all-weather global navigation. It is believed that such applications brought to successful fruition will further the welfare of mankind everywhere.

* Deputy Administrator, National Aeronautics and Space Administration.

More accurate weather forecasts have tremendous economic implications for people everywhere in their homes, on the farms, and at their work. Large monetary savings would accrue to many industries; for example, food processing, hydro-electric power and public utilities.

At present attempts are made to study global weather by balloon soundings at a limited number of points on the land areas and from a few aeroplanes and ships. Properly instrumented satellites enable fast global observation of hurricanes, tornadoes, cloud heights and type, presence of precipitation, thunderstorms, incoming and reflected solar radiation, and perhaps temperatures at various levels.

Meteorology is already a recognised field for international co-operation as an inherently global activity of great significance to human welfare. Many nations can co-operate in the collection, interpretation and application of the large amount of data receivable from meteorological satellites.

N.A.S.A. has an active project under way for a simple form of communication satellite which can be used by any nation or person having the necessary ground equipment without interference with any other user. It is well known that the moon may be used as a reflector of radio and radar signals if very powerful transmitters and very sensitive receivers are used on the ground and the geometrical relations are correct. Satellites can provide smaller moons nearer the earth which require less transmitter power and less expensive equipment. According to some studies, a passive satellite system may prove economically competitive with ocean cable for transatlantic communication. Television or other wide band transmission would be possible over this system.

The basic data needed to determine the practicality of such a system will be determined by launching a large inflatable sphere 100ft in diameter and made of aluminised mylar plastic. A strong radio signal beamed to strike the satellite will be reflected over a wide angle and can be received as a much weaker signal by a highly sensitive receiving antenna pointing toward the satellite.

Manned Exploration of Space

The N.A.S.A. programme objectives, presumably like those of other countries, include the orderly development of means for the manned exploration of space. *En route* to the long-range objective of manned exploration of the solar system are the temporary ballistic flight of man into space and return (already accomplished with animals), orbital flight for one or a few circuits in the simplest vehicle below the level of the Great Radiation Belt, manned flight in advanced manœuvrable vehicles, in larger satellites carrying several men, in permanent manned orbiting space laboratories, manned flight to the vicinity of the moon and return to earth, and manned landing on the moon and return.

N.A.S.A.'s present project in this field, Project Mercury, has been repeatedly described in the international public and technical press. Its successful completion requires the co-operation of several countries in permitting the installation of portable tracking radars, communication stations, and telemetry receiving stations at suitable points along the intended course. Such negotiations are under way.

Even the first steps in the manned exploration of space are very expensive, as may be inferred from the estimated cost of Project Mercury of 200 million dollars or more. The resources required for the advanced missions may well demand a world-wide collaboration and serve to give a true measure of man's response to the challenge to discover and explore the new frontier of our day.

Vehicle Development Programme

An early task of N.A.S.A. was the planning of a programme of rocket and vehicle development which would provide all the desired missions with a minimum number of new rockets and new vehicles. As in other countries, our present vehicles are assembled from rockets developed in the ballistic missile programme and available smaller rockets. For increased thrust, two new developments have been started in the United States: (1) a cluster of existing engines to give an early capability of about 1,250,000 lb thrust, and (2) a new single-chamber rocket of 1,000,000 lb to 1,500,000 lb thrust, which can be clustered to give 6,000,000 lb thrust or more.

In addition to these first stage boosters, several upper stage rockets are under development, including some using high energy fuels. In addition, nuclear rockets are being developed by the Atomic Energy Commission and N.A.S.A. along with the general application of nuclear energy for auxiliary power in space vehicles.

Of particular interest to other countries may be the "Scout" vehicle under development by N.A.S.A. This is a four-stage, solid-propellant satellite vehicle to carry about 150 lb into a 300-mile orbit. It will be much more economical than existing vehicles, hopefully to cost not more than 500,000 dollars per firing. It will satisfy many though not all needs of our scientific programme. We expect to use this vehicle, if its development is a success, in early international co-operative programmes.

The N.A.S.A. programme was reported in considerable detail in the June 22, 1959, issue of *Aviation Week*, the account being based on testimony before Congressional Committees in defence of the budget estimates for the period July 1, 1959, to June 30, 1960. The total estimate for the aeronautical and space activities of N.A.S.A. amounted to approximately 500 million dollars.

There is, of course, much research essential to activities of the type described but carried out on the ground with the aid of suitable equipment for simulating various aspects of the vehicle or space environment. As in many branches of science and technology, contributions will come from a large number of countries by groups without direct access to space vehicles.

Areas of International Co-operation

Throughout the discussion repeated reference has been made to the desirability of international co-operation arising from the global nature of space exploration. The desirable types of activity, it seems to me, are exchanges of scientific and technical information and data, exchanges of scientists, co-ordinated programmes of observation and experimentation, and co-operative programmes of space exploration.

Exchange of information in its usual form consists of the exchange of publications and the holding of international scientific meetings. In the space activities initiated during the I.G.Y. it was found desirable to exchange information on the planning of experiments, to give prompt notice of launchings, early information on orbits, and such other data as would permit participation of others in observations of scientific value.

It has been remarked earlier that space science is not a new scientific discipline but comprises the use of new tools of experimentation by trained scientists in physics, geophysics, astronomy and similar established fields. The exchange of scientists between countries permits a more rapid transfer of the new techniques than can be accomplished by publications or presentations of papers. N.A.S.A. has established a few fellowships available to scientists of other countries and has provided research opportunities to a few guest scientists. Exchange of scientists in addition to providing training in new techniques may also be used for substantive participation of senior scientists in co-operative programmes.

It is obviously desirable that national programmes in the space field be co-ordinated to avoid undesired duplication and to provide the enhanced increase in knowledge that comes from co-ordinated efforts. This co-ordination was well done under the non-governmental international committee for the I.G.Y. (C.S.A.G.I.) and we look forward to the early establishment on a more permanent basis of the Committee on Space Research to continue co-ordination of basic scientific research in the space field. There is need for co-ordination in programme planning, and in the execution of certain programmes. Activities in the tracking of satellites and in the reception of telemetered data, in research on the upper atmosphere and ionosphere by means of sounding rockets launched simultaneously in various parts of the world, in investigation of the ionosphere by observation of radio signals from satellites, and in laboratory and theoretical research in areas supporting space activities are examples of programme areas in which international co-ordination would be most productive.

The ultimate step in international co-operation is joint participation in a single programme with participation of scientists of two or more countries in the design of experiments and in the preparation of payloads for rockets, satellites and space probes. Discussions are under way between N.A.S.A. scientists and their colleagues from other countries with the view of beginning activities of this type.

In view of the large expense of space activities and the consequent support by governments in each country, international co-operation in space activities can ultimately succeed only when supported by appropriate action on a governmental level. Thus the activity of the non-governmental international scientific groups must be supplemented by suitable action at the intergovernmental level.

As most of you know the first steps toward a basis for the furtherance of international co-operation in the peaceful uses of outer space at the governmental level have been taken by the United Nations. By resolution 1348(XIII) of December 13, 1958, the General Assembly established an *ad hoc* Committee on the Peaceful Uses of Outer Space. This Committee met during the period May 6 to June 25, 1959, and prepared a report under date of July 14, 1959, Document A/4141, which will be submitted at the fall meeting of the General Assembly. This report suggests certain general functions and tasks that might appropriately be undertaken within the framework of the United Nations at the present time. The suggestions in the report represent a hopeful first step toward fuller international co-operation. Many of these tasks require consideration at the governmental level, and it is suggested that the General assembly "may wish to consider the establishment of an Assembly committee, composed of representatives of Member States and having such membership as the Assembly may decide, to perform these functions, to report to the General

Assembly and to make recommendations as appropriate." One of the urgent tasks is "to study practicable and feasible measures for facilitating international co-operation." The report discusses international co-operation in the conduct of space activities in considerable detail and the areas of space activity in which international co-operation should be strengthened. Requirements for mutual agreements in such matters as co-ordination of radio frequencies for use in association with space vehicles are noted as well as opportunities for international co-operation in joint projects.

Conclusion

When one considers the vast distances of the solar system—93,000,000 miles to the sun ; 26,000,000 miles to Venus, the nearest planet ; 3680 million miles to Pluto—and when one catalogues the problems to be solved and the new knowledge needed in almost every branch of science and technology from magneto-hydrodynamics to cosmology, from materials to biology and psychology, the magnitude of the task before us becomes apparent. It is a task that challenges the peoples of the earth as a whole. There is room for co-operation of men of many skills and of nations large and small.

Many of you will regard me as ultra conservative to have limited our objective to the exploration of the solar system. This Congress deals with the subject of astronautics—travel to the stars. Is then the travel of man to the stars a futile dream ?

You remember the verse :

> The world will last when gone are we
> Without a trace of thee or me
> Before we came there was no void,
> And when we're gone the same 'twill be.

I wonder. Since the invention of writing, the thoughts, the knowledge and the influence of men who lived long ago have been available to us and our work will be available to future generations. Each age builds on the shoulders of the past. Who then dares to limit the horizons of the physical universe to be ultimately explored by man ? The exploration of space has begun ; it is our task to advance it as much as we can. Who knows where it will end ?

Passenger and Cargo Ship for Lake Victoria

THE successful completion of the assembly of the R.M.S. "Victoria" on the stocks at the yard of Yarrow and Co., Ltd., marked the end of the first stage in the building of this ship for operations on Lake Victoria in the service of the East African Railways and Harbours. Kenya, Uganda and Tanganyika surround Lake Victoria which has an area of about 27,000 square miles, and to meet the needs of these rapidly developing territories the East African Railways and Harbours has expanded transport facilities. Included among these is the pressing need to improve transport services on the lake, since the steamers "Usoga" and "Rusinga," which have operated a weekly service round the lake in opposite directions for about forty years, are quite unable to satisfy the demands for passenger accommodation. Accordingly in 1957 an order for a new ship was placed with Yarrow and Co., Ltd., the ship to be bolt assembled, dismantled and shipped to East Africa to be re-assembled and completed for service under the supervision of the consultants Sir J. H. Biles and Co. The following are the principal particulars of the ship which has been specially designed for operations in the tropics :

Length overall, ft	260
Breadth, moulded, ft	40
Depth moulded to main deck, ft	13
Depth moulded to upper deck, ft	21
Design load draught, ft	9
Load displacement, tons	1500
Service speed, knots	13¼
Range, miles	1500
Horsepower, b.h.p.	1900
Accommodation :	
First Class	68
Intermediate Class	76
Third Class	350
Crew	65

There are two complete decks, the main and upper, a forecastle and a long boat deck, while eight watertight bulkheads provide an adequate standard of subdivision equal to the requirements of the Ministry of Transport.

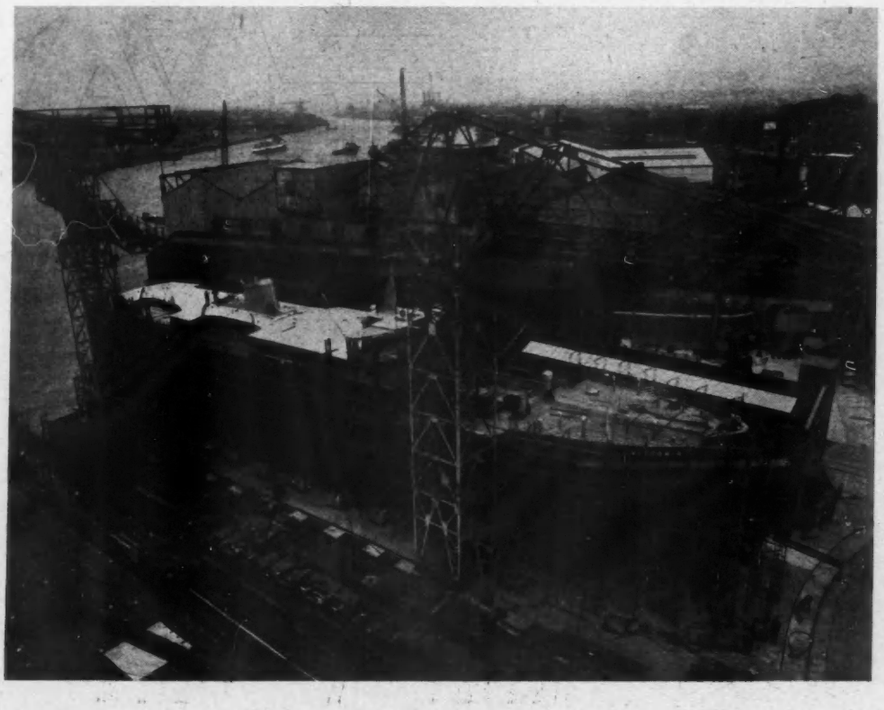
For the first class passengers there are nineteen two-berth cabins in a house on the upper deck and right aft an observation lounge capable of taking another thirty passengers. Forward of the lounge is the dining saloon which accommodates thirty-six passengers at tables to seat two, four or eight. Promenade space is available on the boat deck over which is a permanent awning of aluminium alloy. Forward of midships on the upper deck is a cafeteria for the intermediate class passengers who have their cabins, eleven, each of six berths, on the main deck amidships. Accommodation for the third class passengers consists of two 60-berth dormitories right forward on the main deck and another, further aft, to take twenty-four all fitted with three-tier beds. Within the forecastle is a lounge, to seat seventy-eight, and a tea bar, while just aft of the forecastle is an airing space. Deck officers and engineer officers have their cabins in a house on the boat deck and the remainder of the crew are accommodated aft on the main deck where are also located the main galley and a separate galley for the crew.

Refrigerated cargo is carried in a hold having three compartments with a total capacity of 4400 cubic feet, and immediately aft is a general cargo hold in which provision has been made for the stowage of ten motor-cars. Trunked hatchways give access to both holds and they are served by a Thrige electric crane of 3 tons capacity. In the next compartment are the ship's stores and also a space fitted with racks for the stowage of about forty bicycles.

The whole of the ship is mechanically ventilated, the supply and exhaust fans being manufactured by Woods of Colchester, Ltd. Clarke Chapman and Co., Ltd., supplied the electric windlass and the electric capstan, and Viking Marine, Ltd., built the four 28ft aluminium alloy lifeboats, three of which are of fifty-six persons capacity, while the fourth, powered by a motor, carries fifty-three persons. In addition to the boats which are carried under Columbus Lum pattern davits, there are, for life-saving purposes, six liferafts, each to take twenty persons.

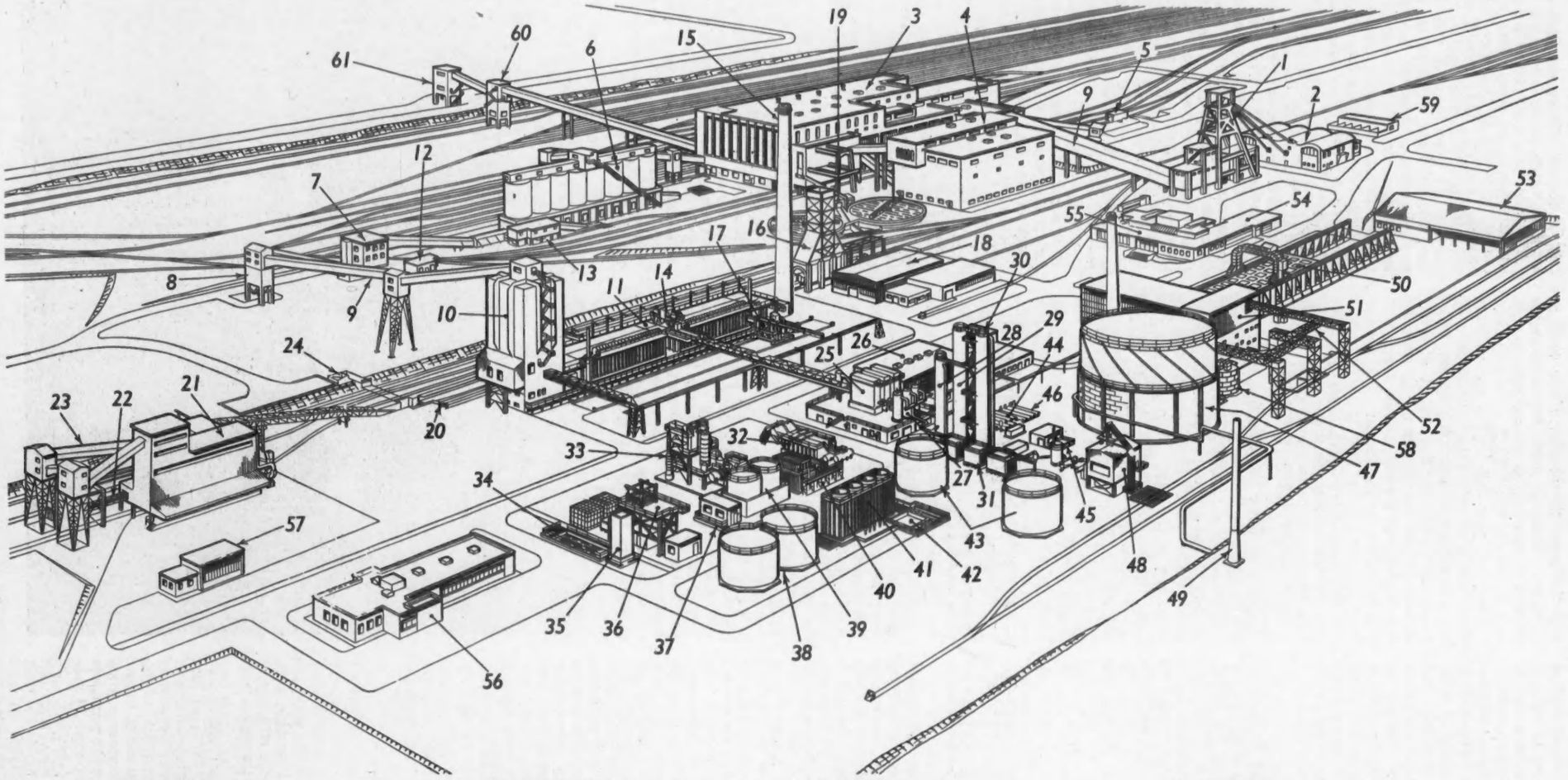
The main propulsion machinery consists of two mark H.R.Vee Crossley two-stroke, reversible, exhaust pulse pressure charged, direct injection, diesel engines having ten cylinders of 10·5in bore by 13·5in stroke. At 400 r.p.m. the engines have a normal rating of 950 b.h.p. but owing to the altitude of Lake Victoria the engines have been derated to 807 b.h.p. Each engine drives a three-bladed propeller of 5ft 6in diameter manufactured by Steven and Struthers, Ltd. All the pumps were supplied by Drysdale and Co., Ltd., and include : a ballast pump and a bilge pump, both rated at 55 tons per hour against a head of 80ft, a 30 tons per hour wash deck pump, cooling water pumps to handle 10 tons per hour and lubricating oil and oil fuel transfer pump of 9·5 tons per hour capacity. There are also De Laval purifiers for the diesel fuel and the lubricating oil both rated at 400 gallons per hour. For the refrigerated cargo and ship's stores, J. and E. Hall, Ltd., has supplied three 22,200 B.Th.U. Arcton 6 compressors, two working and one standby, each driven by a 10 b.h.p. electric motor. To meet the electrical load for auxiliaries and ship's services there are installed in the engine-room two Allen 125kW, 220V d.c. generators each driven by a Lister Blackstone mark E.V.M.6 diesel engine, while for harbour purposes there is a Lister 616 engine driving a 30kW Allen generator.

Our illustration shows the R.M.S. "Victoria" bolt assembled on the stocks for proving and inspection, after which all parts were numbered and painted red or green, to denote port and starboard sides, before being dismantled and crated for shipment. They will be unloaded at Mombasa and travel the 600 miles to Kisumu, on Lake Victoria, by rail. Here the parts will be re-assembled and riveted together on the slipway of the East African Railways and Harbours Dockyard, then launched and fitted out using local labour.



R.M.S. "Victoria" bolt assembled on the stocks

MURTON COKING PLANT



1. Pit shaft headgear.
2. Winding engine house.
3. Coal preparation plant.
4. Raw coal bunkers.
5. Coal track hopper and weighbridge.
6. Coal blending bunkers.
7. Coal crusher house.
8. Vehicle loading hopper.
9. Coal belt conveyors.
10. Ovens coal bunker.
11. Two batteries each of 25 coke ovens.
12. Electrical substation.
13. Breeze crushing and handling plant.
14. Coal charging car.
15. Chimney.
16. Coke quenching station and breeze settling sump.
17. Pusher machine.
18. Workshops, store and office.
19. Clarifier tanks and pump room.
20. Coke wharf.
21. Coke screening station.
22. Boom loaders.
23. Coke belt conveyors.
24. Reclaimed coke wharf.
25. Primary coolers.
26. Exhauster house and control room
27. Electro-detarrers.
28. Secondary cooler.
29. Benzole scrubbers.
30. Gas booster house.
31. Ammonia washers.
32. Liquor flushing and separating tank.
33. Crude benzole plant.
34. Effluent sump.
35. Waste liquor cooling tower.
36. Concentrated ammoniacal liquor plant.
37. Waste liquor sump and pump room.
38. Ammoniacal liquor storage tanks.
39. Crude benzole storage tanks.
40. Wash oil coolers.
41. Water cooling towers.
42. Hot well.
43. Tar storage tanks.
44. Oil/water heat exchangers.
45. Producer plant water sump and pump room.
46. Liquor coolers.
47. Gas holder.
48. Producer gas plant.
49. Gas bleeder.
50. Gas purification plant.
51. Generating station.
52. Telpher handling plant and coal receiving hopper.
53. Oxide store.
54. Administration offices.
55. Bath, locker rooms and canteen.
56. Carbonisation group offices.
57. Sample house. 58. Water treatment plant.
59. Electrical substation.
60. Refuse hopper rail loading.
61. Refuse hopper road loading.

Site arrangement of Murton coking and by-product plant

Murton Coking Plant

The new Murton coking plant of the Durham Divisional Coal Board forms part of a scheme for a combined mine, washery and coke-producing installation. Coal—drawn from the Murton, Eppleton and Elemore collieries at the new Hawthorn shaft—after being cleaned in the washery, is passed to the coking plant. The carbonising capacity of the plant is 1000 *tons of coal per day, from which some* 250,000 *tons of high-grade metallurgical coke will be produced yearly. Purified gas for the gas grid will be available at the rate of* 7,500,000 *cubic feet per day, and the by-product plant will produce concentrated ammoniacal liquor, tar, and about* 1,000,000 *gallons of crude benzole annually.*

IN November last there was placed in operation the new Murton coking plant which forms part of the combined mine, coal washery and coke-making installation of the Durham Divisional Coal Board. Coal is being supplied for this plant from the new Hawthorn shaft, from which the planned output is 1,500,000 tons of coal a year. This new 22ft diameter, 1500ft deep shaft is served by two automatic electric winders drawing coal in 8-ton skips from two levels at 1070ft and 1430ft. The shaft is connected by underground haulage roads to the three satellite collieries of Murton, Eppleton and Elemore. Coal from the shaft is delivered to a new washery which has a capacity of 750 tons of run-of-mine coal an hour. The general arrangement of the coke ovens and by-product plant can be seen in the perspective drawing reproduced on page 192.

The Woodall-Duckham coke oven installation comprises two batteries of twenty-five W.-D. Becker combination underjet ovens, the layout of the plant being such that in the future a third battery can be added at the free end of the bunker. Included in the installation is a coal crushing and blending plant with storage capacity for 3200 tons and facilities for producing the desired blend from the high and low volatile coals available. The coke-handling and screening plant produces six grades of coke and incorporates coke-cutting machinery and provision for road and rail loading. The by-product recovery plant is of the indirect type, in which the gas is cooled and washed for the recovery of tar and ammoniacal liquor. In addition, there is a concentrated ammoniacal liquor plant, a crude benzole plant, a producer gas dilution plant, gas compressing equipment, and provision for water cooling and recirculation. The electrical installation comprises two sub-stations complete with high and low-tension switchgear and main transforming, distribution and control equipment.

Coal is delivered from the washery to the coking plant blending and storage bunkers in sizes of ½in to 0in or 1in to 0in and at a rate of 250 tons an hour. The reinforced concrete bunkers comprise a single line of eight 400-ton capacity compartments and a shuttle belt conveyor installation delivers the coal into the appropriate bunkers as required. From the hopper outlets at the bottom of the bunkers coal is deposited into travelling constant-weight feeders, which are capable of delivering from 15 to 80 tons of coal an hour at a predetermined rate on to an outgoing 30in main belt conveyor. The blended coal is conveyed to the coal crusher house, where it is reduced so that 80 per cent passes through a ⅛in square mesh screen at the rate of 200 tons per hour. The crushed, blended coal is discharged on to a belt conveyor system for delivery into the ovens coal bunker. From the blending bunkers onwards to the ovens bunker the coal handling plant has a capacity of 200 tons per hour, and its entire operation is controlled from a central desk located beneath the blending bunkers.

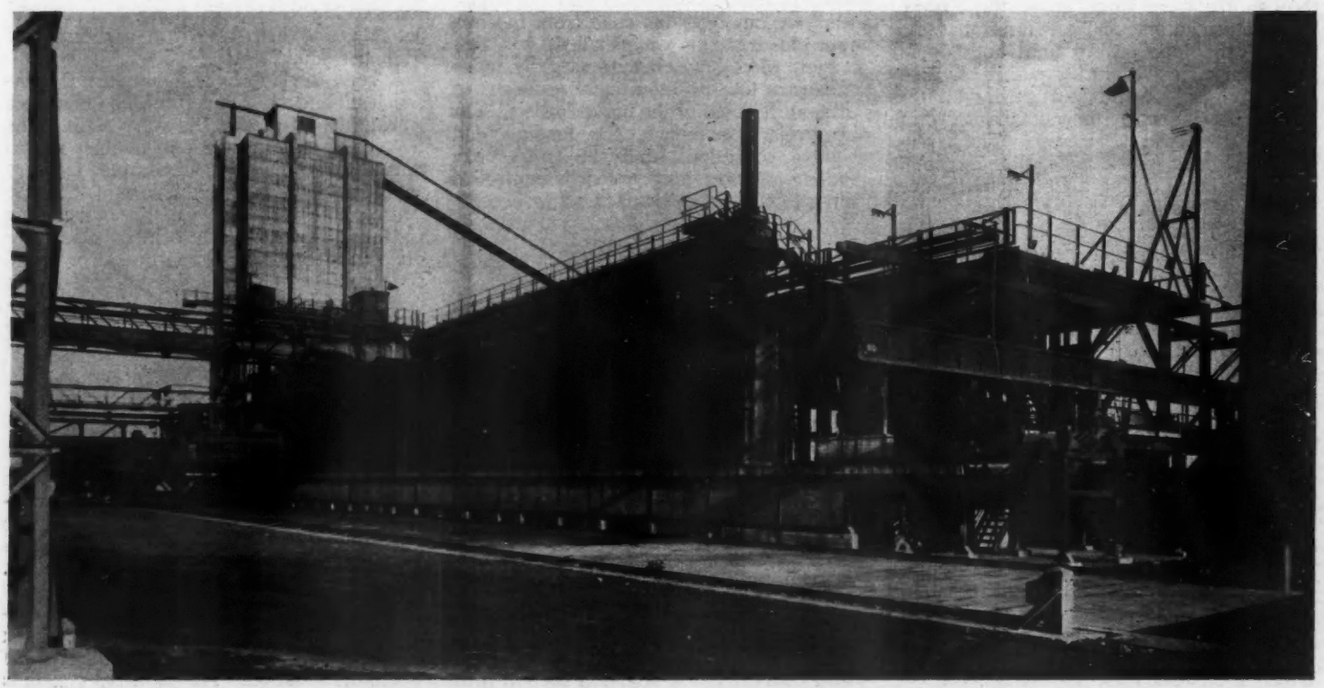
The Oven Installation

The reinforced concrete, 138ft high ovens coal bunker has a total capacity of 2200 tons of coal and there is also a separate compartment of 700 tons capacity which can be used as a test chamber if required. Twelve pneumatically-operated discharge gates on the bunker are connected in rows of four per bay and operated from a coal charging car, which has four steel hoppers with a total capacity of approximately 17 tons of coal.

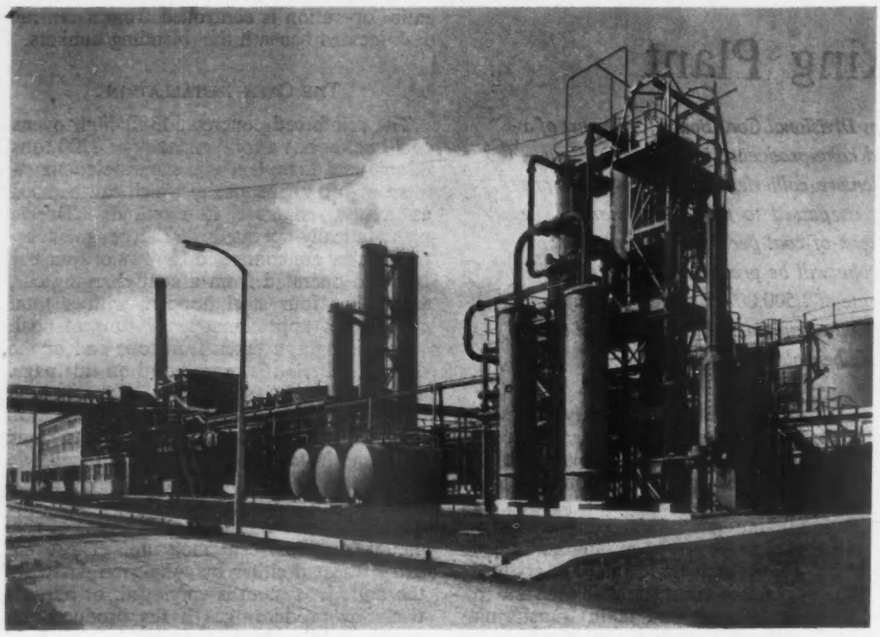
A photograph taken from one end of the oven installation is reproduced on this page. The ovens are arranged in two separate batteries, each with twenty-five combination underjet ovens, which are 40ft 9¾in long between the doors, 13ft high and have an average width of 18in. The capacity of each oven is 735 cubic feet and the batteries are designed to carbonise daily 1000 tons of coal containing 9 per cent moisture. The ovens can be heated either by coke-oven gas when the underjet system is employed, or alternatively by producer gas if the producer gas mains are added in the future.

The fuel gas piping and the underjet firing controls are located in a large basement below the battery structure, which is supported on reinforced concrete beams and columns. The heating system consists of a series of vertical flues on each side of each oven connected by cross-over flues over the top of alternate ovens. Beneath each series of vertical flues and connected to them are two regenerators, each regenerator being divided by a central wall into two sections of half-oven length.

When coke oven gas is used as the heating medium and the underjet system is employed, half of the regenerators (alternate fours in the length of the battery) are utilised to preheat the air. Upon reversal of the valves, which is automatically controlled and occurs at thirty-minute intervals, the coke oven fuel gas is fed through the alternative pairs of cross header pipes and vertical ducts and the air passes through the regenerators down which the waste gas has passed previously.



Pusher side of the oven batteries showing the pusher machine and ovens coal bunker



By-product plant with the crude benzole plant in the foreground

When producer gas is used as the heating medium in the future, the regenerators will be utilised to preheat both the producer gas and the air. The design of these regenerators is such that a regenerator preheating air is always positioned between one through which the producer gas is passing and one in which waste gas is passing. Consequently, there is no possibility of producer gas leaking into the waste gas regenerator.

Coke Handling

A combined pusher machine which travels the length of the batteries levels the charge of coal in the ovens, removes and replaces the oven doors on the pusher side and pushes the charge of hot coke out of the oven. Its pushing operation is controlled by the W-D "Gamma Interlock" system which depends upon a gamma beam passing from the coke guide to the pusher machine through the oven space above the charge. The system automatically ensures that the charge cannot be pushed until both doors have been removed and the pusher machine and coke guide correctly aligned with the oven. The apparatus consists basically of a transmitter and a receiver. The transmitter mounted on the coke guide is a solid steel container housing a Cobalt 60 isotope and provided with a shutter actuated by a hydraulic thruster. When the shutter is opened, a gamma beam passes through the oven roof space and impinges on the geiger counter receiver mounted on the pusher machine. The receiver, incorporating a "fail safe" device, is fitted with a relay which is actuated by radiation and thus closes a master switch on the "ram forward" travel power circuit.

The hot coke is taken by a 40ft long quenching car to a recirculation type quenching station with a reinforced concrete, brick panelled windshield and a timber tower rising 110ft above rail level. After quenching the coke car discharges on to an inclined 150ft long coke wharf fitted with hand-operated regulating gates through which the cooled coke is fed on to a conveyor capable of delivering 75 tons per hour on to a second belt conveyor which elevates it to the primary screen in the coke screening station.

From the primary single-deck vibrating screen which separates the coke at 2½in the oversize is delivered either to a "large coke" boom loader for discharge into rail wagons, or to a coke-cutting machine which reduces it to −2½in. There are four secondary coke screens, the first separating at 1½in; the second screening out the breeze (0in–⅜in); and two final reciprocating screens which grade the coke into the following sizes: ⅜in to ⅝in; ⅝in to ¾in; ¾in to 1in, and 1in to 1½in.

The screening station is a combined structure accommodating the primary and secondary screens, the coke cutters and the six coke hoppers. The five main hoppers have a storage capacity of 30 tons each, and the breeze compartment a capacity of 17 tons. Discharge gates and outlet chutes are provided so that each grade of coke, with the exception of breeze, can be delivered over debreezing screens either on to a "domestic coke" boom loader feeding rail wagons or direct to road lorries.

Rail wagons receiving coke from the two boom loaders are marshalled by two "wagontrolers" which automatically move the wagons into position under anti-spillage chutes at the head of the boom loaders. The wagontroler equipment, the loading and weighing operations, and the entire coke handling and screening system is controlled from a central desk described below.

Producer Gas Plant

Producer gas, for diluting the surplus coke oven gas to a suitable calorific value for town use, is manufactured in two Gibbons Heurtey gas producers, which are 4ft 11in in diameter and of sufficient capacity to serve the present plant and future extension. For cooling and washing the producer gas there are provided two fabricated steel pre-coolers, two spray separators, and one 7ft diameter mild steel gas scrubber.

Gas Collecting System

The crude gas leaves the ovens through ascension pipes on the pusher side of the batteries and passes into the gas collecting mains. At the adjacent ends of the collecting mains there are two gas offtake mains which connect into a common suction main spanning the pusher track and terminating at the downcomer before the primary coolers. The collecting mains have liquor sprays positioned at every alternate oven, and each main is complete with a liquor-sealed bleeder and a pitch trap. The return flushing liquor and the accompanying heavy condensates from the pitch trap of each collecting main return through the suction main and downcomer to the liquor flushing and separating tank. This tank, which separates the tar before recirculation of the ammonia liquor, has a decanting capacity of 34,000 gallons. Tar from the tank overflows into a 5000 gallons receiving tank, whilst the liquor is decanted into a 10,000 gallons tank.

From the downcomer the gas passes to the primary coolers for cooling by indirect contact with water. Two turbine-driven gas exhausters withdraw the gas from the ovens and primary coolers, and discharge it through the by-product equipment. A maximum volume of 874,000 cubic feet of gas per hour can be passed by each exhauster, delivering against a back pressure of 2 lb per square inch. The gas is delivered under pressure to electro-detarrers and the gas is cooled before it enters the ammonia washers. For naphthalene removal there is a secondary cooler using petroleum oil as the cooling medium. The cooled gas passes to three ammonia washers in series, then on to benzole scrubbers and thence to a single-lift, spirally guided gas holder, with a storage capacity of 200,000 cubic feet.

Gas which is not required for under-firing the coke ovens or for use in the boiler plant is diluted with producer gas to reduce its calorific value to 485 B.Th.U. per cubic foot so that it is suitable for distribution. The diluted gas is delivered to a dry purification plant by two oil-cooled booster fans, each of which is capable of delivering 380,000 cubic feet of gas per hour, measured at 60 deg. Fah. and 30in Hg., at an outlet pressure of +40in w.g. when the gas inlet pressure is 6in w.g. The volume of purified gas passing to the boosters is measured by a Holmes-Connersville positive displacement meter having a normal capacity of 12,600,000 cubic feet per day, which is sufficient to serve the present plant and its future extension. Three Belliss and Morcom gas boosters installed are each capable of compressing 5,330,000 cubic feet of gas per day, and delivering it at a pressure of 30 lb per square inch.

A central plant building houses the exhausters and all the principal machines serving the by-product recovery plant. The by-product plant, shown in another of the illustrations, includes a benzole recovery equipment for the production of CS_2-free benzole and it will be capable of handling the full gas load when the coke oven batteries are extended. An automatically controlled concentrated ammonia liquor plant is designed for the production of crude concentrated liquor of 25 per cent strength from crude coke oven ammonia liquor at the rate of 2500 gallons an hour.

Centralised Instrumentation and Control Systems

The noteworthy feature of the Murton coking plant is the centralised instrumentation and control systems provided for the operation of the by-product and benzole plants and the coal and coke handling plants. They provide a degree of automatic control exceeding that hitherto attained in the working of a coking plant, and have resulted in an appreciable reduction in the number of operators required. The principal system is that associated with the by-product and benzole plants for which a graphic panel

some 40ft in length is located in the by-product building. This panel provides continuous information of the flow of coke oven gas, producer gas, ammoniacal liquor, tar, benzole, wash oil, water, steam and air. Most of the operation of the plant is controlled from the centralised panel, which was designed by Woodall-Duckham and manufactured by Foxboro-Yoxall. It consists of a central graphic section with wing panels at each end and employs some eight controllers and recorders together with pilot indicator lights, alarm signals and other devices.

On the graphic panel the representation is arranged horizontally with the main gas stream shown moving from left to right. Individual items of the plant are portrayed on the panel and the instruments and associated equipment are mounted at appropriate points relative to their functions. The various process lines are colour coded to denote the nature of the product flowing through them. Where there are alternative or stand-by units on the plant only one unit is shown on the panel but, to enable the operator to determine which unit is in operation, a system of tell-tale lights provides identification. These tell-tale lights are additional to an alarm system.

The indicating and recording instruments are actuated by pneumatic signals received from transmitters situated at the requisite measurement points on the plant. The panel-mounted controllers transmit set-point signals to the actual control units located close to their associated control valves. In instances where a recorder is linked with a controller and functions as a control station the set-point adjustment can be made from the front of the panel. The controllers are force balance instruments which respond instantly to the smallest changes in measurement and set pressures, and are capable of four-control action : proportional, proportional-derivative, proportional-reset and proportional-reset-derivative. In the indicators a red nylon ribbon behind a graduated glass scale creates a rising and falling column effect.

A wing is set at a slight angle on each side of the graphic section of the panel. The right-hand wing is provided, primarily, to present essential information required for budgetary control which falls outside the scope of the graphic presentation. Its instruments record steam pressures, and record and integrate steam flows to the individual plants. The left-hand wing contains two key switch potentiometers, a multiple column mercury manometer, and an annunciator board which forms part of the comprehensive alarm system. The potentiometers enable the operator to take additional temperature readings from points where continuous readings are not required, whilst the multiple columns of the manometer are arranged to demonstrate the progressive changes of gas pressure in the gas purification system.

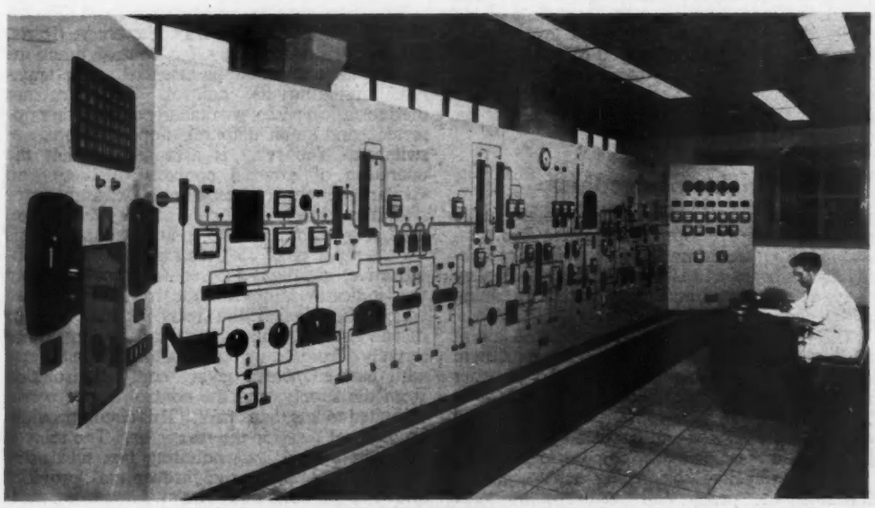
An annunciator board at the top of the left wing gives audible and visual warnings when selected measurements depart from normal values. The warning consists of the ringing of an alarm bell which coincides with the appearance of flashing lights on the graphic panel and the relevant annunciator section, showing where the measurement has deviated. The pressing of the acknowledgment button by the operator silences the bell and switches the signal lights to steady, and when the necessary corrective action has been taken the panel and annunciator lights are automatically restored to normal.

The coal handling plant control desk, illustrated herewith, is located in a dust-free, air-conditioned room beneath the blending bunkers. The desk incorporates an illuminated mimic diagram panel which records all the information necessary for the required operation of all machines and conveyors from the point where washed coal is delivered at the blending bunkers until it is discharged into the ovens bunker. The panel shows which conveyors are running, the position of all flygates, and the amount of coal stored in the various bunkers. The stopping and starting of the coal stream is controlled from switches on the desk, and before any item can be started up a series of warning bells are sounded in their vicinity. The plant can be started in the correct order according to the setting of the flygates, the positions of which are given by appropriate illumination on the panel. The control switches are coloured to differentiate between the sections of the plant.

The dust-free, air-conditioned room for the coke-handling plant control desk is located above the wagontroler and weighbridge gear house at the screening station. On its desk a diagram panel and various indicator lamps show which sections of the plant are in operation and whether the coke hoppers are full or empty. High and low-level indication for the hoppers depends upon gamma rays obtained by using suitably positioned and shielded Cobalt 60 radio-active isotopes accommodated between the sides of the coke bunkers and the adjacent walls.

By remote push buttons, coloured control switches and a system of warning bells, similar to the coal-handling control, the operator can control the correct sequence operation of the whole of the handling and screening system. The desk also incorporates means for controlling the wagontroler at the boom loaders, and for marshalling, weighing and loading empty wagons and weighing and marshalling full wagons.

Coal handling plant control desk



By-product and benzole plants control panel in the central by-product plant building

Power Supplies

The generating station serving the site houses an Allen five-stage turbine which drives a Mather and Platt alternator. This set uses 33,000 lb per hour of steam and exhausts to the low-pressure main at 160 lb per square inch and 475 deg. Fah. Under these conditions, which will ultimately be the normal steam loading from the coking plant, the set has an output of 860kW at 3·3kV, three-phase, 50 cycles. In parallel with the turbo-alternator, duplicate pressure reducing and attemperating equipment is installed, each set being capable of carrying the coking plant steam load. In addition to supplying the coking plant proper, an additional pressure reducing and attemperating equipment is installed downstream of the turbine to provide steam for the purifier boxes and also small quantities of heating steam, &c., to the pit head buildings.

The steam supply to the coking plant is provided by three Clarke Chapman stoker-fired boilers, each of 20,000 lb per hour capacity producing steam at 615 lb per square inch and 815 deg. Fah. These boilers, in addition to firing South Hetton smalls (calorific value approximately 11,000 B.Th.U per pound) on the chain grates, are also designed to fire excess gas from the coking plant in periods of low gas demand. Fuel blending equipment is also installed so that a mixture of South Hetton smalls and coke breeze can be burned. Normally two boilers are on load providing approximately 33,000 lb per hour of steam through a high-pressure steam ring to the turbo-alternator.

Main Contractors: Woodall-Duckham Construction Company, Ltd.

Main Sub-Contractors and Suppliers: Coal and Coke Handling Conveyors, W. J. Jenkins and Co., Ltd.; Coke Screens, General Electric Company, Ltd., W. J. Jenkins and Co., Ltd.; Debreezing Screens, A.C.E. Machinery, Ltd.; Blending Bunkers and Ovens Bunker, Truscon, Ltd.; Gas Producers, Gibbons Brothers, Ltd.; Gasholder, Newton Chambers and Co., Ltd.; C.A.L. Plant, R. and J. Dempster, Ltd.; Electro-Detarrers and Ammonia Washers, Whessoe, Ltd.; Gas Exhausters, Richardsons Westgarth (Hartlepool), Ltd.; Timber Quenching Tower, The Visco Engineering Company, Ltd.; Cooling Tower, Film Cooling Towers (1925), Ltd.; Ovens Machines, The Wellman Smith Owen Engineering Corporation, Ltd.; Coal Crusher, British Jeffrey-Diamond, Ltd.; Coke Cutters, Robert Cort and Son, Ltd.; Wagontrolers, Nortons-Tividale, Ltd.; Heating and Ventilating Plant, The Visco Engineering Company, Ltd.; Instruments, Central Control Panel, Foxboro-Yoxall, Ltd.; Coal and Coke Handling Control Desks, Central Electric Company, Ltd.; Pumps, Joseph Evans and Sons (Wolverhampton), Ltd., Gwynnes Pumps, Ltd.; Electrical installation, W. H. Smith and Co. Electrical Engineers, Ltd.

SHORTER REPORTS

Mobile Demonstration Unit for Electronic Control Equipment

To show European countries the developments it has made in electronic machine tool control systems and other automatic equipment, E.M.I. Electronics, Ltd., Hayes, Middlesex, has had built the mobile demonstration unit we illustrate on this page. The first visit of this unit will be to the European Machine Tool Exhibition, which opens in Paris on September 12 next. It will afterwards visit Amsterdam, Dusseldorf, Stuttgart, Zurich, Basle, Milan, Turin, Lyons and Brussels.

The unit comprises a Commer 12-ton diesel tractor hauling a specially designed 25ft long semi-trailer based upon a 12-ton drop-frame chassis. The sides and end of the body can be swung out to provide platforms and canopies all round the working area, and an enclosure at the front provides a programmer's office in which the punched tape is prepared for the machine under demonstration.

The tractor has a 105 b.h.p. opposed-piston, two-stroke engine with blower-assisted scavenging, and power is transmitted through a constant-mesh, five-speed gearbox and a two-speed rear axle. It is equipped with power-assisted steering and pneumatic/hydraulic brakes. Power for the equipment being demonstrated is supplied by an alternator driven from the engine power take-off, constant engine speed for this purpose being ensured by a C.A.V. all-speed hydraulic governor fitted to the fuel injection pump.

The unit is equipped with a new Kearney and Trecker design milling machine with a three-dimensional E.M.I. punched tape control system. Whilst demonstrations are in progress on the machine a closed-circuit television system can be used to show the work in progress to a wider audience than can be accommodated in the working area. With this new demonstration facility it will now be possible for the firm to show a typical machine in operation at a potential customer's works and on the actual class of component he is manufacturing.

Mobile demonstration unit fitted out as a complete workshop with an electrically controlled milling machine, a programmer's office and a closed-circuit television system

London Motorway Proposal

THE Ministry of Transport and Civil Aviation is planning a 4-mile motorway through the borough of Hendon, the purpose of which, the Ministry states, is "to cope with the greatly increased traffic expected to pass through Hendon as a result of the opening of the first section of the London-Yorkshire motorway later this year." The Ministry's appraisal of the problem goes on to assert that: "Traffic needs in the immediate future will be met by the existing route A.41 between the L.C.C. boundary at Finchley Road and Apex Corner, which, together with A.1 north of Apex Corner, is being improved to dual carriageway standard. But this route also serves the Great North Road, which is being modernised as far as Newcastle. It is likely, therefore, to become seriously overloaded within a few years unless an alternative route towards Central London can be found."

The Minister, Mr. Watkinson, appointed Messrs. W. S. Atkins and Partners, consulting engineers, to report on this problem and it is on their recommendation that he has decided to have a draft scheme prepared under the Special Roads Act, 1949. The proposed motorway would start from a point where West End traffic converges on A.1 near Page Street, follow fairly closely the line of the London Midland Region Railway on its east side for some distance, and pass under Watford By-pass a little to the west of Apex Corner. It would then cut northwards through open country for some distance before turning west near Mill Hill North Cross to rejoin the Watford By-pass A.41 near its junction with A.5 at Brockley Hill. The road would have dual carriageways and would cross under or over all existing roads without any intermediate junctions or access points. The draft scheme showing the line of the proposed road may be published early next year, we are informed, and there will be the usual statutory period of three months for lodging objections. The scheme is estimated to cost some £3,000,000.

Anglo-American Moon Echo Experiment

EARLY on August 25 radar signals transmitted from the 45ft diameter radio telescope at the Royal Radar Establishment, Malvern, on a wavelength of 10cm, were successfully received in Texas after reflection from the moon. This was the outcome of a joint experiment between members of the Radio Astronomy Group at the Royal Radar Establishment and the Electrical Engineering Research Laboratory of the University of Texas, and was an extension of the programme by the Radio Astronomy Group on the study of the surface of the moon using radar. The peak transmitter power was 2MW and the signals were 5-microsecond pulses with a p.r.f. of 250 per second. By comparison of the signals received at the two sites it is hoped to find out more about the surface conditions of the moon and also how the moon could be used as a reflector for transmitting radio and television signals for long distances over the surface of the earth. In the previous moon-echo experiment, from the 250ft diameter radio telescope at Jodrell Bank, frequency-modulated telephony signals were sent on a wavelength of 1¼m (see our May 22 issue). The transmitter power on that occasion was 1kW.

Portable Sludge Pump

A NEW portable ejector-type self-priming sludge pump recently developed by Holman Brothers, Ltd., Camborne, Cornwall, is designed for working at low heads and is capable of handling very dirty, contaminated and gritty water containing a high percentage of solids.

The pump is operated by compressed air at 80 lb per square inch and provides a maximum delivery of 43 g.p.m. with a 10ft head of water and is capable of operating with heads up to 50ft to deliver 35 g.p.m. It weighs only 78 lb and can be easily carried and handled by one man; it needs only a single-tool compressor.

Self-cleaning and self-sealing ball valves are fitted in the pump and acid-resistant inner mechanisms are used to obviate the risk of corrosion when handling acidic waters.

The pump comprises essentially a main tank and top and bottom cover assemblies. In operation it is controlled by a float within the main tank which actuates an air valve in the top cover.

This valve opens and closes as the liquid rises and falls within the tank. When the pump is empty the top cover air valve is open, allowing compressed air to pass from a ¾in inlet through the valve to atmosphere, providing an ejector effect, causing a vacuum within the tank. A ball valve which acts as a non-return valve in the bottom cover then allows water from the source to enter the pump through a strainer. The water and float rise until the float closes the air valve in the top cover. As the air cannot now escape to atmosphere, it pressurises the tank and forces the liquid down. This movement closes the non-return suction valve in the bottom cover and the water then leaves the pump through the non-return delivery valve in a 2in delivery pipe. A time lag mechanism is fitted which allows the float to drop to a predetermined level before the air valve opens to restart the pumping cycle.

Transistorised Control Relay

WE have received particulars from Electro Methods, Ltd., Caxton Way, Stevenage, Herts, of a transistorised relay for control functions where minimum arcing is essential in the apparatus initiating the control. Examples are thermostatic devices, particularly contact thermometers, and small diaphragm-operated pressure switches. The relay is arranged so that the operation of external contacts of these and similar types either biases or unbiases a transistor and allows the internal control relay to operate. This relay is fitted with load current contacts with a capacity of 15A a.c., at 250V a.c. (non-inductive) and light-duty contacts for switching two indicator lamps on the front of the case which show when the relay is energised or de-energised. Control current is derived internally from a double-wound transformer with earthed screen giving complete isolation from the supply, and the control circuit power is limited to less than 5mW. This circuit provides the control bias for the transistor. The relay is fitted in a steel wall-mounting box measuring 6½in high by 4½in wide by 3½in deep, and provided with two ¾in conduit entries at the bottom. It is available for mains supplies of 200/220V or 230/250V, 50 to 60 c/s, a.c.

Television Lighting for Reactor Charge Machine

THE problem of providing lighting for television cameras on a nuclear reactor charge machine has recently been investigated experimentally by the Illumination Department of the Research Laboratories of The General Electric Company, Ltd., at Wembley. The experiments, carried out in conjunction with the G.E.C. Atomic Energy Division, Erith, formed part of the development work on the charge machine for Hunterston nuclear generating station.

At Hunterston the machine will be situated beneath the reactor, as shown in the drawing reproduced in our February 8, 1957, issue, and its movements will be monitored on the control desk both by instruments and by closed-circuit television. It was necessary to determine camera positions and lighting details before fabrication of the pressure vessel for the machine, and since these could not be deduced reliably by calculation from the drawings, a full-scale wooden model of the operating mechanisms concerned was built at Erith and re-erected at Wembley for experimental tests. The model was built on its side, for convenience in operation, so that the principal movements were horizontal rather than vertical, and represented the top part of the charge machine, occupying a roughly cubic space of 12ft side. Operations such as removing and stowing the standpipe door and concrete shield plug, locating the charge tube, inserting and withdrawing fuel elements, could all be simulated.

In the actual machine, illumination will be by 125W, high-pressure, mercury-vapour lamps, mounted on the outside of the pressure vessel and shining through glass windows. For the purpose of the experiments a frame representing the pressure vessel wall was erected at the correct distance from the model, and the lamps, behind simulated sight glasses, mounted on the frame. Positioning was found to be quite critical. Certain mechanisms are masked by others and pointers had to be attached to them to show their movements. During the tests it was found that the two-dimensional presentation of an essentially three-dimensional object sometimes produced the optical illusion of "inversion," that is, a nearer edge sometimes appeared to be further away. The solution to this particular difficulty has been found by painting contrasting stripes on some parts of the mechanisms to accentuate their shapes and emphasise their true perspective. Special care is required in selecting the paints. One reason is that the inside of the machine effectively forms part of the coolant-gas circuit and there are severe restrictions on the types of material that may be introduced into this circuit. In addition, the radiation intensity due to spent fuel elements withdrawn into the machine will be very high. With the arrangement finally chosen it was found possible to obtain good pictures with an illumination of 10–40 lumens per square foot.

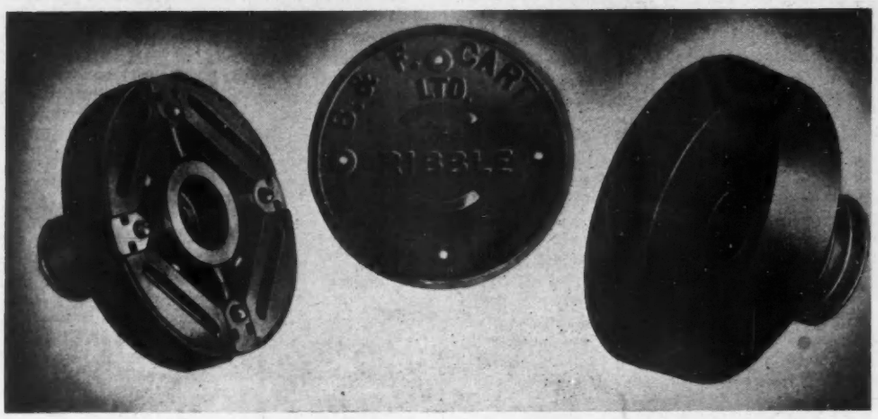
Strategic Transport Aircraft

SOME details are now available of the design of the Short "Britannic," construction of the first of which will commence shortly. It will be recalled that this large long-range freighter is a derivative of the Bristol "Britannia," but has a much enlarged fuselage able to accept loads up to 12ft wide, and the undercarriage fitted in sponsons as is customary on transports for use on poor airfields. The version which has been selected for initial manufacture is the "Britannic" 3A of 218,000 lb all up (85,000 lb payload), which bears an interesting relationship to the "Britannic" 3 of 195,000 lb (75,000 lb payload): in order to allow propellers larger than the 16ft diameter "Britannia" units, a 16ft centre section has been incorporated—the wings of a "Britannia" join on the aircraft centre line—and the inboard nacelles, which no longer house the landing gear, have been moved 4ft further from the tip, thus allowing 20ft diameter airscrew discs. The span is now 158ft 9·65in: a further modification to the wing is that the fuel tanks are now integral, as on the Canadair "Britannia" derivative, the CL-44, and this has increased the tankage about 20 per cent—the military requirements are for air-dropping stores, but not troops, and the aircraft is not expected to be exposed to damage by enemy action.

With four Rolls-Royce "Tyne" engines of 5730 t.e.h.p., it is expected that the range with capacity payload and 20 per cent reserves will be 1150 statute miles, cruising at 340 m.p.h.: with the capacity fuel load of 81,200 lb, 25,000 lb payload can be flown 5050 miles at the same speed. Civil applications of the machine, which should have specific costs roughly half those of to-day's aircraft, have been studied, and it appears that the operating costs will vary little over the band-500 to 2500-mile stage length. With high density seating, up to 249 passengers could be carried on two decks. A complete freight handling system affording rapid turn-round is to be developed by the makers for installation at termini, based on pallets which fit along a road vehicle (7ft 6in wide) and across the "Britannic" (11ft long).

Institute of Metals Visit to Sweden and Denmark

FROM September 21 to 25, 1959, the fifty-first annual autumn meeting of the Institute of Metals will be held in Sweden by invitation of Bolidens Gruv A.B., A.B. Svenska Metallverken and the Metallografiska Institutet, Stockholm, with an extension to Denmark by invitation of the Danish Society of Metals. At the opening session on Monday morning, Professor E. Rudberg, Director of the Metallografiska Institutet, Stockholm, is to deliver the Autumn Lecture on "Life with Metals, Now and Tomorrow." On Tuesday morning there are to be two scientific programes: the theme of the three papers of (A) being "The Production of Fine Copper Wire for Enamelling," and that for the three papers of (B) "The Corrosion of Aluminium." The concluding scientific session is planned for Thursday morning as a discussion of a paper entitled "Extrusion as Compared with Other Methods for the Manufacture of Bar, Rod and Wire-Rod in Copper and Copper-Base Alloys." On each of the five days in Stockholm visits to works or all-day tours are planned for the members and ladies and male guests. In the evenings there are to be, first, a cocktail party at the British embassy, then a banquet and dance, and finally a council dinner for the Institute's hosts. The long week-end in Copenhagen on the return journey includes a sightseeing tour, and visits of especial interest.



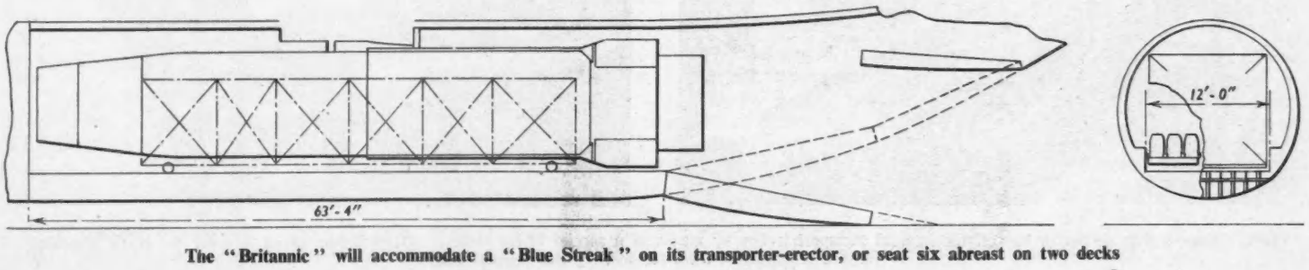
Component parts of spring-controlled, automatic centrifugal clutch

Centrifugal Clutches

WE are informed by B. and F. Carter and Co., Ltd., Albion Works, Bolton, that the "Ribble" automatic spring-controlled centrifugal clutch is now available in a range of stock sizes covering requirements from 1 h.p. to 9 h.p. at 1400 r.p.m. These clutches, which are effective in both directions of rotation, are designed to take a load smoothly and without shock up to the operating speed and stop without damage or overloading of a drive.

The general construction of one of these clutches can be seen in the photograph we reproduce of an opened unit. The main components include a driving member with four arms the ends of which project between four loose weights faced with friction linings. A flat steel spring passes freely through each of the weights and has its ends fitted into slots at the extremities of the driving arms. The drum of a casing, which provides the driven member, registers over the weights and the weights are retained in their axial position during rotation between the inner face of this member and an aluminium cover plate. A screw which is threaded through the inner face of each weight presses against the side of its spring and is adjusted initially to hold the weights clear of the casing when the clutch is stationary. When the driven member is rotated the weights automatically move outwards under centrifugal force to transmit drive to the casing.

The casings are made of high tensile close-grained cast iron and for their mounting on the flanges of the driven members are bushed with self-lubricating, oil-impregnated, phosphor bronze sleeves designed to give a long working life without need for lubrication. The friction linings are bonded to the weights which are individually balanced after assembly.

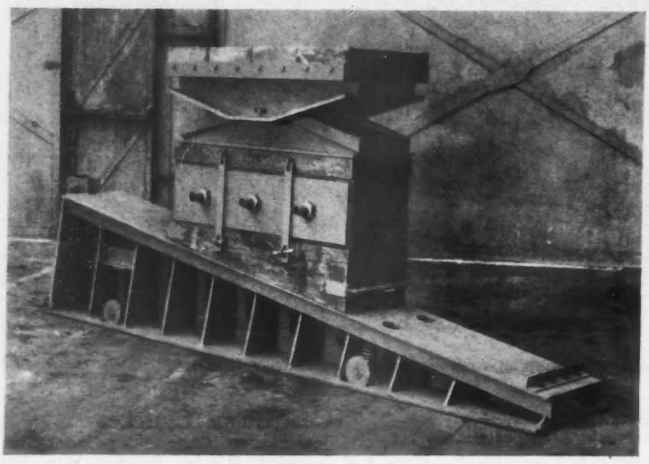


The "Britannic" will accommodate a "Blue Streak" on its transporter-erector, or seat six abreast on two decks

Bilge Block Assemblies for a Dry Dock

ABOUT a year ago, we described in these columns a new dry dock at Falmouth* where hydraulically-operated mechanisms had been installed to position the bilge blocks in the dock, according to the shape of the vessel about to be docked. We recently received particulars of another installation of this general kind which has been installed at the Duke of Edinburgh dry dock at Swansea, which is owned by the Prince of Wales Dry Dock Company, and was opened in June.

In this new dock, the conventional method of supporting the vessel in the pumped out dock, viz., by shoring from the altar steps and dock walls, has been replaced by adjustable bilge blocks on the dock floor. The bilge blocks are positioned according to the structure of the vessel being docked, and operated by gears in service tunnels on either side of the dock, the movement being accomplished by two sets of chains between the gears and the blocks. Twenty sets of blocks, ten on each side, are available in the new dock.



Adjustable bilge block assembly

The bilge blocks themselves were manufactured and supplied by Superwelds (Lewisham), Ltd., Princes Road, Dartford, Kent, in co-operation with the consultants, Messrs. G. Maunsell and Partners, and consist of pivoted timber-faced blocks resting on fabricated steel wedges approximately 10ft 6in long, as shown in the accompanying illustration. The blocks are free to slide up or down the wedges, relative movement being achieved by chains at each end. Thus, the heights of the blocks above the dock floor depend on their position on the wedges which themselves can be positioned along axes at right angles to the keel.

The operating gears consist of two chain wheels mounted side by side on concentric shafts passing through the dock wall and carrying chains which transmit motion to the bilge blocks through guide pulleys on the dock floor. The inner ends of the shafts connect to a manually-operated dog clutch mechanism which permits the drive to be taken on both shafts simultaneously or alternatively to one shaft whilst the other is held motionless. It is thus possible to move both blocks and wedge together or one relative to the other.

The driving motors used are standard portable compressed air drilling machines which can be easily carried from station to station, and are connected by quick-acting couplings to reduction gearboxes mounted on frames on the tunnel wall. Indicators coupled to the final drive shafts give positive indication of the position of the bilge blocks relative to the keel of the vessel.

In operation, the dock is pumped out until the keel settles on the keel blocks on the dock floor. The level of water in the dock is then reduced by a further 6in or so to ensure that the weight of the vessel is taken on the keel. The bilge blocks and wedges, in their lowest positions, are run in together from the dock wall to their predetermined positions; the blocks are then held stationary and the wedges advanced until the blocks are in contact with the hull. Stalling of the driving motor indicates that the required pressure between the block and the hull has been reached, and the blocks and wedges are then locked together and no further movement can take place. The dock is then pumped dry in the usual way. Since the torque of the driving motor is constant, all blocks will have the same initial bearing load.

The blocks and wedges are fabricated from mild steel plate and sections, welded joints being used throughout. Care was taken in manufacture to ensure freedom from distortion, which might disturb the even spread of the load, although timbers between the wedge and the swivelling blocks provide a small measure of flexibility in the vertical direction and permit dismantling whilst under load if necessary. When the wedge is traversed across the dock floor, sprung wheels reduce the frictional forces. These wheels retract into the wedge as soon as load is applied. Maintenance has been reduced to the minimum.

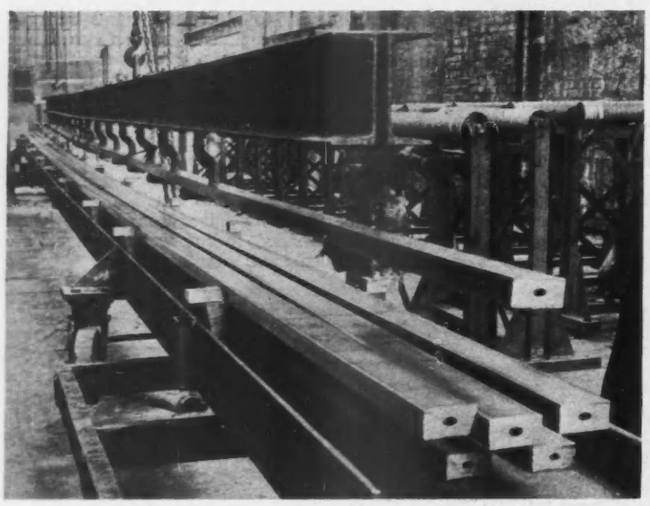
* "The Queen Elizabeth II Dock, Falmouth," THE ENGINEER, August 8, 1958.

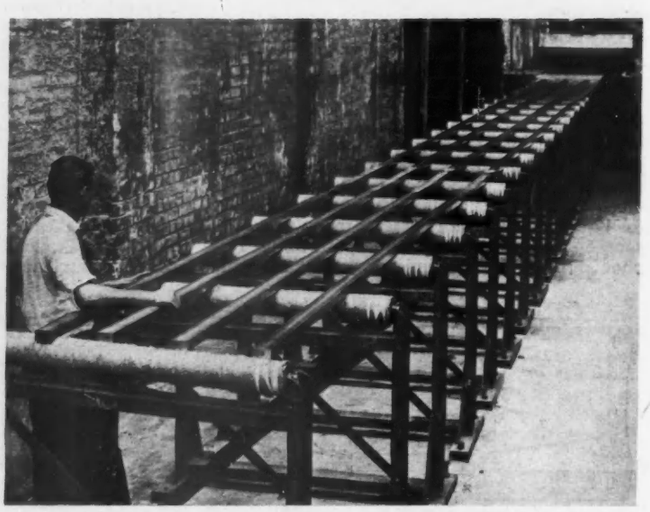
Magnet Coils for 7GeV Proton Synchrotron

THE first of the copper rectangular conductor bars for the magnet coils of the 7GeV proton synchrotron ("Nimrod") for the Rutherford High Energy Laboratory, Harwell, are now being despatched to Manchester from the Argyle Street works of James Booth and Co., Ltd., Nechells, Birmingham, 7. At Manchester they will be fabricated into the finished coils by the Metropolitan-Vickers Electrical Company, Ltd. Construction of the 7000-ton magnet for the proton synchrotron by Joseph Sankey and Sons, Ltd., Wolverhampton, was described in our May 29 issue.

The bars are 2⅝in by 1⅛in in cross section and have a central hole ⅝in by ⅜in through which demineralised water will be pumped for cooling purposes. Some of the bars are over 57ft long, and this gave rise to a number of problems not only of manufacture but also of handling and transport. Extrusion is carried out on a large hydraulic press. Since close dimensional tolerances are required, the bars, after pickling, are cold drawn in several stages to the final dimensions and shape. At the fabrication stage the bars will have to be bent, and a bright annealing furnace is used to produce the dead soft condition required. Inspection is carried out at the factory under the supervision of a representative of The United Kingdom Atomic Energy Authority. The dimensional accuracy of the central hole, seen in both the accompanying illustrations, is tested by blowing a ball bearing of the appropriate size through its length.

The bars weigh about 8 cwt each and in view of their soft condition, and the fact that they have to be dead straight, they require frequent support along their length when being lifted from point to point at various stages of manufacture. Specially designed beams were constructed for this purpose and, in lifting, two overhead travelling cranes are employed so as to give support to the load in all positions. For moving the bars from shop to shop a special truck, 60ft long, was constructed on the premises. Even so, the difficulty of negotiating the truck with its load round a number of bends had to be met and in some cases this required structural modifications to some of the shops. During transport to Manchester it is essential that the bars lie flat along their entire length and reach their destination in this condition. They are being taken in a specially constructed vehicle by a selected route. In all, about 300 tons of copper conductor bar are being supplied and delivery of the order is spread over about a year.





(Left) Lifting a 57ft conductor bar off the internal transport trolley by means of a special lifting beam. (Right) Bars about to enter the bright annealing furnace to condition them for winding into magnet coils

Industrial and Labour Notes

Unemployment

The Ministry of Labour states that on August 17, there were 426,857 people (307,315 men and boys and 119,542 women and girls) registered as unemployed in Great Britain. Between July 13 and August 17, the number of unemployed increased by 32,000, the wholly unemployed rising by 40,000 and the "temporarily stopped" falling by 8000. Expressed as a proportion of the estimated number of employees unemployment on August 17 was 2 per cent, compared with 1·8 per cent a month earlier.

The Ministry points out, however, that the number of adults unemployed declined by 6000 in August whilst the number of unemployed boys and girls increased by 38,000. It is estimated that when the count was taken on August 17, about 42,000 school leavers had not entered any employment. But in the five-week period ended August 12, the employment exchanges filled 199,000 vacancies, the number of vacancies notified but remaining unfilled being 263,000, or 12,000 less than at the beginning of July.

Wages and Earnings

Changes in wage rates which came into operation during July resulted in an aggregate increase estimated at about £183,000 in the weekly full-time wages of 730,000 workpeople and in a decrease of £23,000 for 477,000 workpeople. The decreases, of course, occurred in those industries in which there is a sliding scale arrangement based on the official index of retail prices. Those who received increases include road haulage workers and workers in the electrical contracting industry.

The Ministry of Labour reports that, in the first seven months of this year, changes in wage rates led to 3,489,000 people receiving increases aggregating £835,100 a week. In the comparable period of last year there was an aggregate increase of £1,476,000 in the weekly full-time rates of wages of 5,119,000 people. At the end of July, the index of rates of wages (January 31, 1956 =100) stood at 117 for all workers, which indicates a rise of one point since January. Taking the manufacturing industries only, the index figure was 116 at the end of July, there having been no change in it since last October. The Ministry has also stated that, in the last pay week in April, the average weekly earnings of manual workers employed in the manufacturing industries generally and in a number of the principal non-manufacturing industries in the United Kingdom were : men, £13 2s. 11d. ; youths and boys, £5 14s.; women, £6 17s., and girls £4 7s. 4d. The average hours worked in that week were : men, 48 ; youths and boys, 44·6 ; women, 41·5 ; and girls, 42·3.

Ravenscraig Strip Mill

It has been announced this week that the contract for building the 68in semi-continuous hot strip mill at the Ravenscraig works of Colvilles, Ltd., has been placed with Davy and United Engineering Company, Ltd. The value of the contract is stated to exceed £4,000,000. The mill will include a 42in vertical edging scale-breaker, a 44in by 68in horizontal scale-breaker, a 39in and 56in by 68in reversing roughing mill with attached 33in vertical edger, a rotary crop shear, a 28in and 56in by 68in six-stand finishing mill, two downcoilers and coil unloaders, and associated roller tables and ancillary equipment. A substantial part of the design and manufacture of the 9000 tons of machinery covered by this contract is to be done at the Glasgow works of Davy and United Engineering Company, Ltd.

Export Prospects

The economic and marketing research unit of The General Electric Company, Ltd., has commented on the outlook for British exports in the latest issue of the *G.E.C Export Guide*. It describes the current prospects for the third quarter of this year as "good" in fourteen countries, "improving" in ten countries, "deteriorating" in six countries and "bad" in four countries. The countries in this last category are said to be India, Norway, Spain and South Africa. Those in which Britain's export prospects are thought to be deteriorating are Finland, Iraq, Kenya, Malaya and Singapore, New Zealand and Venezuela.

Electrical Industry Film

At the annual general meeting of The General Electric Company, Ltd., on September 3 the Chairman, Sir Leslie Gamage, presented as a supplement to his speech a new film illustrating the company's activities as a whole. This is the first film made for the G.E.C. of such comprehensive scope, although numerous others dealing with particular items of work and research have been issued previously. In sixteen minutes the new film, entitled "In the News," shows activities as diverse as domestic cookers and nuclear power station construction. An important function of the film is to interest employees in the achievements of the company, and the sequences have therefore been planned to cover some of the less familiar work undertaken by the organisation, such as automatic reel-changing equipment for rotary printing presses and medical X-ray apparatus. Arrangements have been made for showing the film to employees at G.E.C. branches and works and it is hoped that there may be public showings at cinemas in areas where there are groups of G.E.C. establishments. Widespread circulation by film libraries is being arranged and public overseas showing may be possible through the C.O.I. The film, in black and white, was made by the Film Producers' Guild and is available in 35mm and 16mm sizes.

Dockers' Pensions

The National Association of Port Employers on August 27 formally offered a pension scheme for employees to the unions in the dock industry. A pension of 10s. a week plus a lump sum payment on retirement of £100 is proposed for the 1900 registered dockers over the age of seventy, these men to be retired after a period of grace when the scheme comes into effect. Subsequently, a gradual reduction of the retirement age to sixty-five is envisaged. For new entrants, and dockers joining the scheme at twenty-five or under, the pension on retirement after forty years' minimum service would be 40s. a week. Men of twenty-five and over would receive weekly payments and lump sums on retirement in varying proportions according to age. Weekly contributions would be 2s, 6d., and would be compulsory for new entrants, but voluntary for those already in the industry. All benefits would be in addition to payments from other sources, such as the State retirement pension. The cost to employers has been estimated as about 5s. a week for each man in the scheme.

Construction Work in Second Quarter

Provisional figures compiled by the Ministry of Works indicate a further rise in value of constructional work carried out by contractors in the second quarter of the year. This totalled £481 million in the three months which ended in June, or £33,000,000 more than in the first quarter of the year, and £24,000,000 more than in the second quarter of 1958. Value of new housing work rose by £11,000,000 compared both with the first quarter of this year and the second quarter of last year, reaching £143 million. New work other than housing for public authorities rose to £115 million, an increase of £15,000,000 compared with the previous quarter and £10,000,000 more than in the second quarter of last year. It is provisionally estimated that at the end of July 1,047,000 operatives were employed, virtually the same as in July, 1958. More men were employed on repair work and fewer on other new work than a year earlier. Costs continued slightly below the 1958 level and there was no change in the provisional index number of construction costs for the second quarter of the year.

Data Processing Study Team

The European Productivity Agency is to send a European team to the United States in April–May, 1960, to study integrated data processing. An on-the-spot survey of methods will be made and equipment from simple mechanical aids to electronic computers will be studied. It is particularly the solutions open to small and medium-size firms that will be examined. Applications for inclusion in the team should be made to Mr. V. M. Green, British Productivity Council, 21, Tothill Street, London, S.W.1, before September 11, 1959. The team will be limited to twenty members. A three-day preparatory meeting for selected participants will be held in Paris in December.

Coal

The country's total coal stocks now amount to 46,280,000 tons, of which 31,110,000 tons are undistributed stocks held by the National Coal Board. A year ago, the figure for undistributed stocks was 13,106,000 tons. In the thirty-four weeks of this year ended last Saturday, coal production amounted to 134,426,500 tons, or about 5,000,000 tons less than in the comparable period of last year. Home coal consumption this year, up to August 22, was 120,425,000 tons, which was approximately 11,000,000 tons under the amount used in the corresponding period of 1958.

Tubular Turbines

THE continually increasing demand for electric power has stimulated the development of sources of hydro-electric energy—low head and tidal power—which, until recently, were hardly considered worthwhile on account of high installation costs in relation to the expected output. In the last twenty years, however, there have been some spectacular technical advances, notably a development of the Kaplan propeller turbine, known as the tubular turbine or, as it is frequently called, the bulb turbine. One of the chief firms concerned, Escher-Wyss A.G., Zürich, since 1936 has delivered seventy-five bulb turbines with a total output of approximately 143,000 h.p.

One of the characteristics of the tubular turbine is the straight line internal flow. In order to minimise losses, in the first larger-size machines the rotor of the generator surrounded the (fixed) blades of the propeller runner, a design which involved questions of frictional losses and sealing problems. Smaller units were designed with a generator in a bulb surrounded by the flowing water; the first 265 h.p. turbine of this kind, shown in Fig. 1, was built by Escher-Wyss in 1936 for the Rostin power station in Pomerania. Its generator was accommodated in the hub of the guide-vane apparatus, which was fitted with stationary vanes. A butterfly valve was employed as closing means. This line of development culminated in a turbine built in 1951 for the Lech power station, which has a generator surrounding a variable pitch runner, and also possesses an adjustable guide-vane apparatus by which means the advantages of the double-regulating Kaplan turbine can be fully utilised.

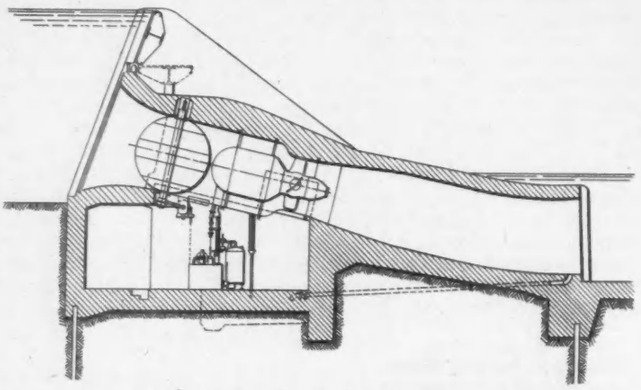


Fig. 1—Power station at Rostin (Pomerania, 1936). The synchronous generator is accommodated in the hub of the guide apparatus which has hollow and stationary vanes. A butterfly valve is employed as closing means

Although at that time tubular turbines did not generally receive the attention they deserved, the engineers of Escher-Wyss were convinced that further research would eventually eliminate the still existing drawbacks of this turbine and within the inherent limits of this design (small and medium quantities of water and low heads) would produce turbines with efficiencies equal to or even better than conventional Kaplan machines.

Development work, taken up shortly after the end of the second world war, was mainly directed towards improving the hydraulic flow. To this end the generator was mounted inside the draft tube, and a supporting structure, carrying the radial bearings and the thrust bearing, was arranged upstream of the runner. The ribs of this structure also served as guide vanes. Fig. 2 shows a cross section of a turbine with an output of 180 h.p. at a head of about 13ft, which was installed at the Ravensburg works of Escher-Wyss in 1956. Apart from the position of the generator in the draft tube, the turbine is remarkable for having a step-up epicyclic gear between the adjustable-pitch four-bladed runner and the generator which increases the turbine speed of 280 to 1000 r.p.m. The higher speed permits the use of a smaller generator which not only improves the flow conditions in the draft tube but also required less space in the power house. The reduction in overall efficiency resulting from the epicyclic gear is compensated by the better efficiency of the high-speed generator.

It could be argued that such generators have to be designed for a very high runaway speed. This drawback, however, has been overcome by the adoption of an oil-pressure-controlled brake which holds the annulus of the epicyclic gear during normal operation, but releases it when a given overspeed is reached, thereby interrupting the flow of mechanical power from the turbine to the generator. Whilst the turbine goes up to the runaway speed for which it is designed, the speed of the generator drops so that it remains outside the danger zone.

Another bulb turbine, the design of which is basically similar to that of the Ravensburg turbine, has been in use since July, 1956, at the Osberghausen power station of the Rheinisch-Westfälisches Elekrizitätswerk A.G., Essen; it was ordered as an experimental plant in connection with the projected harnessing of the Moselle River. This turbine utilises a head of 24ft and has an output of 530 h.p. at 312 r.p.m. with a speed increase to 1015 r.p.m. at the generator. Here again an epicyclic gear is employed, similar in principle to the Ravensburg turbine, except that the oil-pressure-controlled brake of the annulus is released by means of springs should the oil pressure fail. Tests carried out to ascertain the reliability of this system showed that when suddenly throwing off load, the turbine runner reached a maximum speed of 770 r.p.m., whilst the generator, after lifting the brake, attained a maximum speed of only 1320 r.p.m. These figures lie far below the calculated runaway speed of 3800 r.p.m. for a design without the release brake.

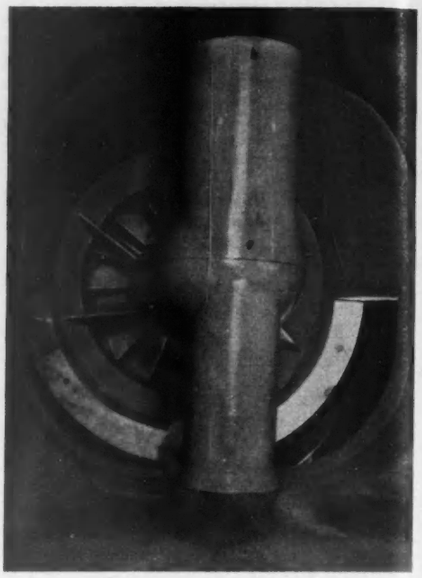
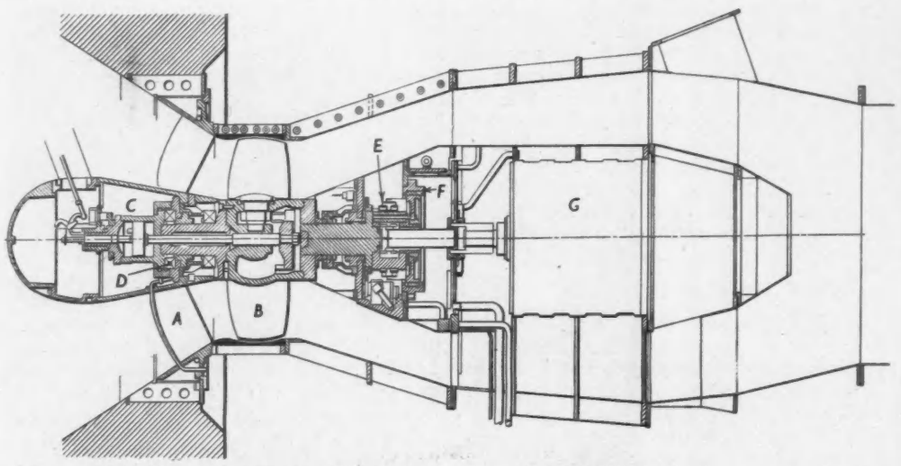


Fig. 3—Wooden model made for aerodynamic tests, viewed towards the inlet. The upper rib contains the access shaft; the guide apparatus is arranged behind the inlet member

Fig. 4—Turbine installed at Burglen power station

The arrangement of the generator in the draft tube, although an improvement compared to earlier layouts, did not entirely fulfil the expectations of the designers, and was soon superseded by a new construction having the generator installed in the turbine inlet. The main reason for this was to avoid increasing the

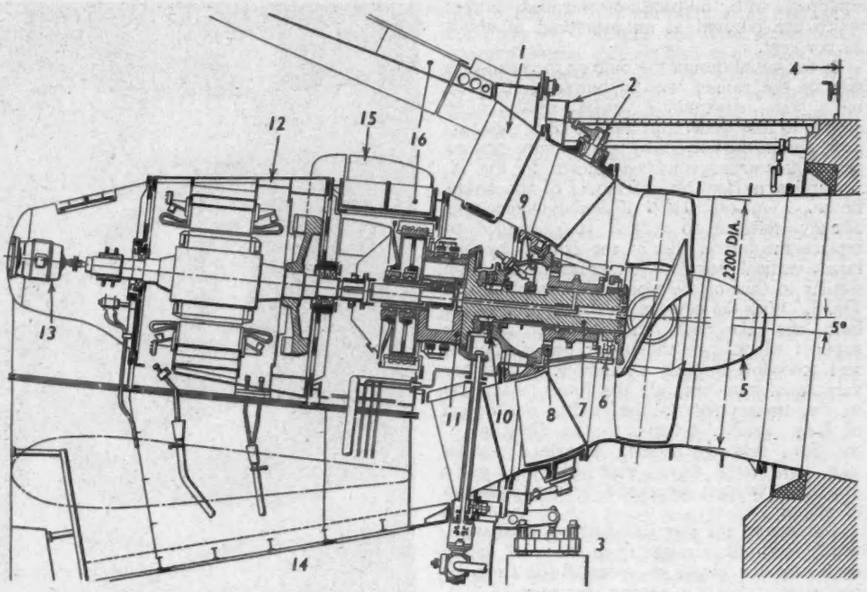


A—Guide apparatus with stationary vanes.
B—Adjustable runner wheel.
C—Servo-motor for runner regulation.
D—Axial thrust bearing.
E—Planetary gear.
F—Oil-controlled gear brake.
G—Generator.

Fig. 2—Tubular turbine with generator arranged in centre of draft tube (Ravensburg works power station and Osberghausen power station)

overall length of the turbine, including the draft tube, and to reduce the resulting frictional losses. The latest design arranges the individual components of the bulb turbine in the following order. After a short converging section at the inlet comes the bulb containing the generator, then the step-up gear, the variable-pitch runner and lastly a well-designed, comparatively short draft tube. This has the great advantage that no special measures have to be taken to ensure a smooth flow of the water issuing from the runner wheel; the conversion of the kinetic energy can take place over the shortest distance and with maximum efficiency. Moreover, the generator is then located in a quiet flow area where components can be better and more accessibly accommodated than in the draft tube. Although tubular turbines are for the greater part submerged in larger units, all important components are accessible through an open shaft accessible from the power house. This shaft acts as a thick rib supporting the turbine hub and is streamlined in such a way that the resulting loss of energy is only slightly greater than that of a supporting vane. The realisation that the power loss caused by the rib would be kept comparatively small led to the provision of an additional shaft in the form of a thickened hollow rib on which the whole erection of the turbine can be effected. A combination of upper and lower vertical ribs of sufficient rigidity generally permits any further lateral supports of the generator to be dispensed with. Fig. 3 shows a wooden model for aerodynamic tests, showing the generator bulb with the upper manhole-rib and the lower supporting rib; the speed ring and the guide-vanes are arranged behind the generator.

The first tubular turbine with the generator arranged in the inlet was built by Escher-Wyss for Messrs. Böhi A.G. in Bürglen (Switzerland)



1—Speed ring.
2—Adjustable guide apparatus.
3—Servo-motor of guide wheel with closing weight.
4—Governor.
5—Runner wheel with servo-motor in hood.
6—Stuffing box.
7—Shaft.
8—Bearing with control oil supply.
9—Restoring means of runner.
10—Thrust bearing.
11—Planetary gear with brake between runner wheel and generator.
12—Generator.
13—Pendulum generator.
14—Supporting feet with cold air ducts.
15—Lateral supporting arms with hot air discharge.
16—Openings for dismantling purposes.

Fig. 5—Section through turbine at Reutte (Tyrol) with generator in inlet

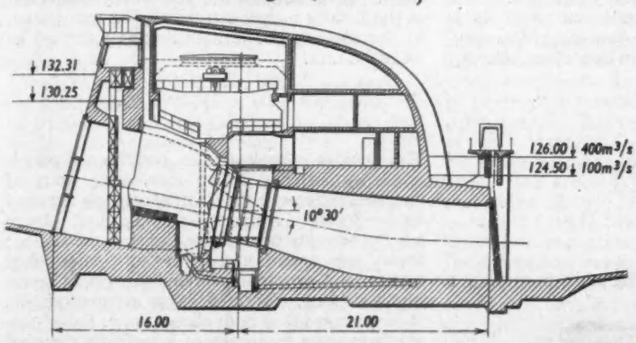


Fig. 6—Proposed turbine installation for the Moselle, comprising four turbine sets, each developing 6000 h.p. at 78 r.p.m., under a head of 16ft approximately

and has been in operation since October, 1956; it develops 610 h.p. at 113 r.p.m. and utilises a head of 10ft. In this turbine the two-stage planetary gear is arranged in front of the generator as it is more accessible there and the turbine shaft is connected to the gear through the hollow generator shaft. The turbine shaft is overhung and its discharge fairing accommodates the servo-motor for the blade adjustment; the guide vanes are stationary. The whole casing is submerged and is supported by four hollow ribs (Fig. 4), two of which supply cooling air to the generator whilst the other two discharge the warm air. The epicyclic gear of this turbine is not equipped with a release brake, but the generator is designed to withstand racing during the closing period of the gate, which is located in front of the inlet screen.

The turbine for the Reutte power station on the River Lech in the Tyrol (Fig. 5) has a head of 20ft and develops 1690 h.p. at 165 r.p.m., this speed being increased to 1000 r.p.m. at the generator by an epicyclic gear with release brake. The turbine is fitted with adjustable guide-vanes, the journals of which are led outside and are connected by crank arms and links with the oil-pressure-actuated control ring. The whole turbine unit rests on a profiled hollow rib through which cooling air is supplied to the generator; the warm air is discharged through two additional laterally arranged supporting arms. The erection of the whole set can take place on the vertical rib, for which purpose openings are provided in the outer walls of the water inlet tube. The Reutte power station has two of these turbines, and the whole plant is submerged. An impounding sluice regulates the head-race level; it can be entirely lowered, in which case the plant is completely flooded.

From the preceding description of small or medium-sized installations, built by Escher-Wyss in the last twenty years, it might appear that the use of tubular turbines is restricted to smaller water courses. This, however, is not strictly correct because, from projects and also from installations already in an advanced stage of erection, it is evident that for a number of applications tubular turbines of considerable size can be preferable to standard vertical Kaplan turbines, both from the hydraulic as well as from the economical point of view. The most important of these projects is that of harnessing the Moselle River, a scheme involving several stages of similar head and a large number of turbines of practically the same size. The planning and the preliminary intensive experimental work, which was done by Escher-Wyss in collaboration with their German subsidiary company at Ravensburg and with French firms, was mainly concerned with the problem of finding a prototype that would embody all the advantages of a tubular turbine within the framework of the whole project.

Although at present only one of the several planned stages of the Moselle hydro-electric power scheme is nearing completion, it is possible to visualise the layout of the other, basically similar stages from a preliminary project drawing, showing a power station for four tubular turbines, each developing 6000 h.p. at 78 r.p.m. at an average head of about 16ft (Fig. 6). The turbines have variable-pitch runners and adjustable guide-vanes and are fitted with epicyclic gears to give a speed of 750 r.p.m. at the generator. The gears are

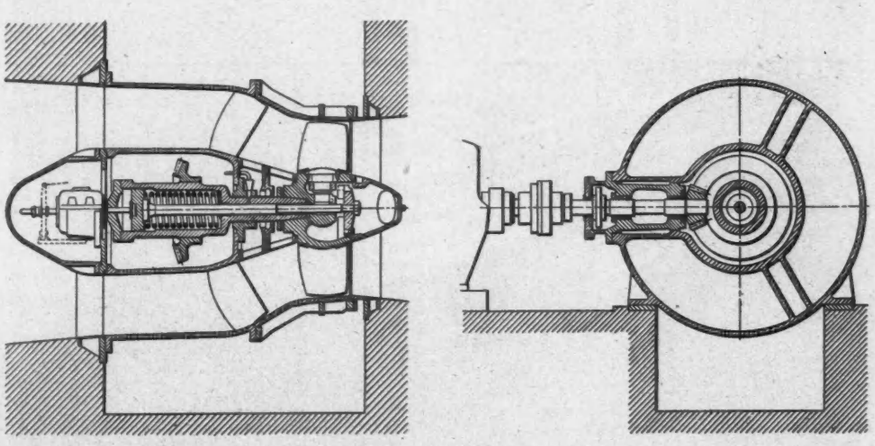


Fig. 7—Standard design for small outputs of up to 300kW, equipped with stationary guide blades and bevel transmission between runner and generator. The servo-motor is fitted with a spring to close the runner in case the oil pressure fails

equipped with oil-pressure-controlled brakes which are released at an overspeed of about 30 per cent.

In the initial design the bulb on the head-race side of the runner was supported at the top by a wide, streamlined vertical shaft, giving access to the generator and to the speed-up gear, and at the bottom by two laterally inclined ribs ; this arrangement is shown in Fig. 8, presenting a view on the model of the power house. On the basis of aerodynamic tests already referred to it was later decided to replace the lateral ribs at the bottom by one large vertical support underneath the bulb similar to that of the wooden model shown in Fig. 3. With the new design the erection of the bulb can take place on the lower concrete support which, like the upper one, is hollow and accessible through a manhole. These two substantial ribs take all the forces that have to be transmitted to the walls ; although of large section relative to the direction of the flow, they are profiled in such a manner that the water flows past to the guide apparatus without separation or the formation of eddies.

The axis of the complete turbine installation, which is almost straight from the inlet to the draft tube exit, slopes by about 10 deg. from the horizontal. With a runner diameter of 15ft, the overall length of the set is about 120ft, and the lowest point of the installation is only 26ft below the normal level of the tail-race. Model tests indicate that the efficiency of the turbines will exceed 90 per cent over a fairly wide range of heads and flow quantities.

Most of the turbines built in recent years have been equipped with epicyclic gears. There is, however, a certain demand for small and inexpensive units which can be satisfied by a comparatively simple design in which the generator is located outside the water tube and is driven from the turbine by a bevel gear. Fig. 7 shows a section of such a unit with a speed-up bevel gear positioned in the bulb in front of the controllable-pitch runner ; the high-speed transmission shaft is led outwards through a hollow rib and is connected to the generator. The turbine has stationary vanes, and there is a strong coil spring on the non-controlled side of the runner servo-motor which effects closing of the blades should the oil pressure be interrupted. The oil-control gear and the governor are belt driven from a pulley on the transmission shaft. Such turbines are completely assembled at the factory ; they can usually be transported to the site without dismantling and erected as an entire unit.

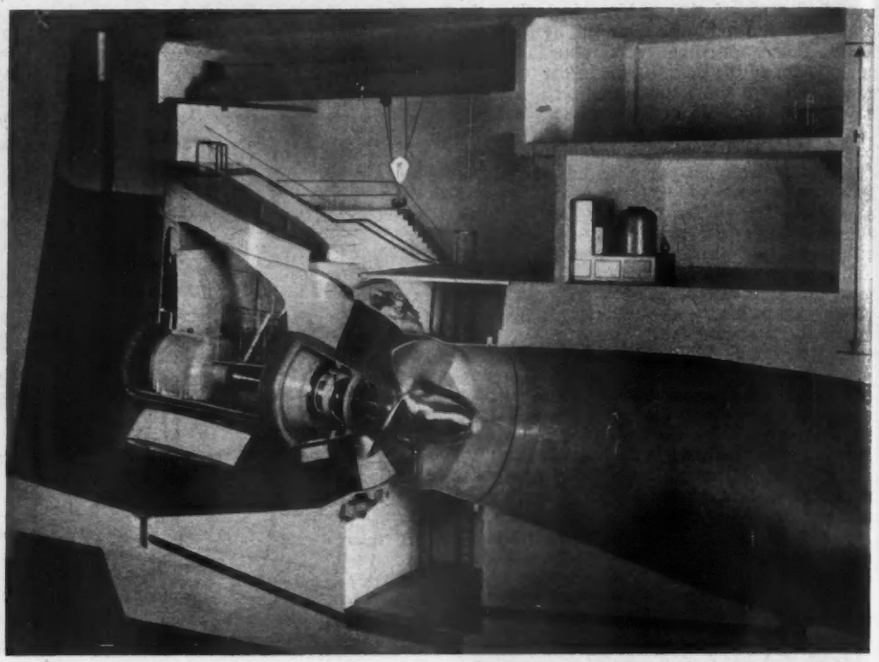


Fig. 8—Model of Moselle turbine. The runner has a diameter of 4·7m. The whole of the installation is situated below the upstream water level (OW)

Holland-America Liner S.S. "Rotterdam"

OUR illustration shows the S.S. "Rotterdam," the new flagship of the Holland-America Line, and the fifth to bear the name, which was built by the Rotterdam Drydock Company and engined by N.V. Koninklijke Maatschappij "De Schelde." The liner, which has a very distinctive profile and sailed on her maiden voyage to New York on September 3rd, has the following main particulars :

Length between perpendiculars	650ft
Breadth moulded	94ft
Depth moulded to main deck...	54ft 6in
Draught loaded...	29ft 6in
Gross tonnage	38,650
Displacement	31,530 tons
Propelling machinery :	
Two sets of double reduction geared turbines...	35,000 s.h.p.
Service speed	20·5 knots
Passengers in two classes...	1,456
Officers and crew	776

Holland-America liner S.S. "Rotterdam" on trials

The ship is completely air conditioned and is fitted with Denny-Brown stabilisers, while of particular interest is the steering controls supplied by the Sperry Gyroscope Company, Ltd. There are five steering control positions on the bridge : these are incorporated in an interlocked system and provide for hand-electric or automatic steering. The passenger accommodation is so arranged that both classes enjoy run-of-the-ship privileges by means of a specially designed main staircase in combination with passenger lifts. This system has resulted in a horizontal layout of accommodation instead of the more usual vertical one in which the different classes of passenger are confined to either the forward, midships or aft ends of the ship.

The two sets of triple-expansion turbines of Parsons design take steam from four oil-fired boilers, at 640 lb per square inch and 860 deg. Fah., and drive through double reduction, single helical gearing to give a propeller shaft speed of 131 r.p.m. Electrical power for auxiliaries and the ship's services is generated by four turbo-alternators, which develop 5400kW at 440V, while for emergency purposes there is an Allen 350kW alternator driven by a gas turbine.

Swiss Nuclear Station

"Suisatom S.A.," which was founded in 1957 by the A.T.E.L., F.M.B., N.O.K. and E.O.S. Electricity Companies, has applied for a permit to build a nuclear station on the left bank of the river Aar, in close proximity to the Würenlingen plants. The sponsors of this project are the four biggest power companies in Switzerland, producing 80 per cent of the country's requirements in electrical energy.

The reactor which has been selected belongs to a type which has already been thoroughly tested abroad. For safety's sake the station will be installed in a rock cavern. Work is to start in January, 1960, and is scheduled to be finished during the first half of 1963.

Nuclear-Powered Passenger-Cargo Ship "Savannah"

BY OUR AMERICAN EDITOR

No. I

The world's first nuclear-powered passenger-cargo ship, the N.S. "Savannah," was launched at the Camden yard of the New York Shipbuilding Corporation in New Jersey by Mrs. Dwight D. Eisenhower on July 21. The 22,000-ton vessel was constructed under a joint contract with the U.S. Maritime Administration and Atomic Energy Commission and will be operated under Government contract by the States Marine Lines. The "Savannah" will be capable of carrying sixty passengers and 9500 tons of cargo at a speed of 21 knots. She will be able to operate for more than three years on the initial 52,000 MWD (megawatt-day) fuel loading of her pressurised water reactor. Her trials are scheduled for the spring of next year.

ONE hundred and forty years ago, on May 22, 1819, a 320-ton ship started a voyage from Savannah, Georgia, to Liverpool. She was the "Savannah," the first vessel to use steam on a transatlantic crossing. As the "Savannah" ushered in the steam age in ocean travel, it was considered fitting that another "Savannah" should usher in the atomic age. After President Eisenhower signed the bill authorising the construction of the first nuclear-powered merchant ship, he accepted the suggestion of American shipping circles and named her the "N.S. Savannah."

The project to build the N.S. "Savannah" was undertaken in keeping with the policy of the President and the Congress to foster and develop the American Merchant Navy and to demonstrate to the world the intent of the United States to employ the power of the atom for peaceful, productive purposes. The development of this nuclear-powered cargo-passenger ship was the joint responsibility of the Maritime administration of the U.S. Department of Commerce and the U.S. Atomic Energy Commission. The combined effort is being carried on through a joint group known as the Nuclear Projects Office in the Maritime Administration, and as the Maritime Reactors Branch in the Atomic Energy Commission. The vessel was designed by George G. Sharp, Incorporated, and is now under construction at the New York Shipbuilding Corporation at Camden, New Jersey. The Babcock and Wilcox Company holds the prime contract for the propulsion machinery, including the reactor, with the De Laval Steam Turbine Company as the subcontractor for the turbines, reduction gears and other heavy machinery.

The building of a nuclear-powered merchant vessel was first proposed by President Eisenhower in a speech in New York on April 25, 1955. Construction was authorised by Public Law 848 on July 30, 1956, with the vessel to be built by the U.S. Maritime Administration and the U.S. Atomic Energy Commission. The States Marine Corporation of Delaware will operate the ship as general agent for the Maritime Administration. The contract with the Babcock and Wilcox Company for the development and fabrication of the nuclear propulsion system was signed on April 4, 1957. The contract for the construction of the "Savannah" was signed with the New York Shipbuilding Corporation on November 15, 1957. The keel was laid on National Maritime Day, May 22, 1958, and the ship was launched on July 21, 1959, with Mrs. Dwight D. Eisenhower acting as sponsor. The construction of the vessel will be completed and the ship ready for loading of her nuclear fuel by early 1960. It is expected that the "Savannah" will undergo extensive testing during the spring of 1960, and that she will be ready for unrestricted operation by summer 1960.

From its inception, it has been acknowledged that the "Savannah" itself will not attain economically competitive operation; nor is she intended as a prototype. Rather, it has been planned to utilise this "first generation" nuclear-powered merchant vessel to develop practical construction and operating technology and to employ this information in evaluating and designing "second and third generation" nuclear-powered ships which can attain competitive performance in free enterprise. It is planned that the "Savannah" will be a test ship. Many special features, such as the provision for extensive remote operation of components and the possibility of rapid manœuvring rates, which are not essential for the proper performance of this ship, have been incorporated for evaluation in future designs. During operation it is fully expected that components, and even entire plant systems, will be changed, when it is indicated that significant improvement can be made. Finally, the "Savannah" has five important missions: (1) to demonstrate to the world the employment of nuclear power as an instrument of peace for the benefit of mankind; (2) to bring the power of the atom into the market places of the world in peaceful trade and commerce; (3) to enlighten the public to the fact that nuclear-powered ships are entirely dependable and safe; (4) to stimulate early solutions to such problems as international liability and indemnification, and win for nuclear ships acceptance in the world's ports, and (5) to give the U.S. Maritime Administration and the U.S. Atomic Energy Commission the opportunity for prudently assessing the possible contributions of atomic power to the progress of the American Merchant Navy in providing shipping services on routes essential for maintaining the flow of the foreign commerce of the United States.

The "Savannah's" rather elaborate provisions for shielding, reactor containment, ship structural integrity, safe storage of all wastes and the continuous monitoring of every potentially hazardous condition, are results of several years of study. These designs have been reviewed and accepted by the U.S. Coast Guard, the American Bureau of Shipping and the U.S. Public Health Service, and will meet the recommendations of the A.E.C. Advisory Committee on Reactor Safeguards. In every case, design and construction practice has followed the recommendations of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society for Testing Materials, and other technical institutions.

Design of Vessel

The "Savannah" (Fig. 1) is a single-screw, passenger-cargo sheltered deck vessel of advanced design, with a raked stem and a modified cruiser stern. The vessel is fitted with three complete decks. Ten main transverse, watertight bulkheads divide the ship into eleven 'thwart-ship compartments. The hull is built on a transverse framing system except for the inner bottom, which is a combination of transverse and longitudinal framing especially stiffened in the reactor area to provide positive protection to the nuclear steam plant in case of ship collision. The vessel meets a two-compartment standard of sub-

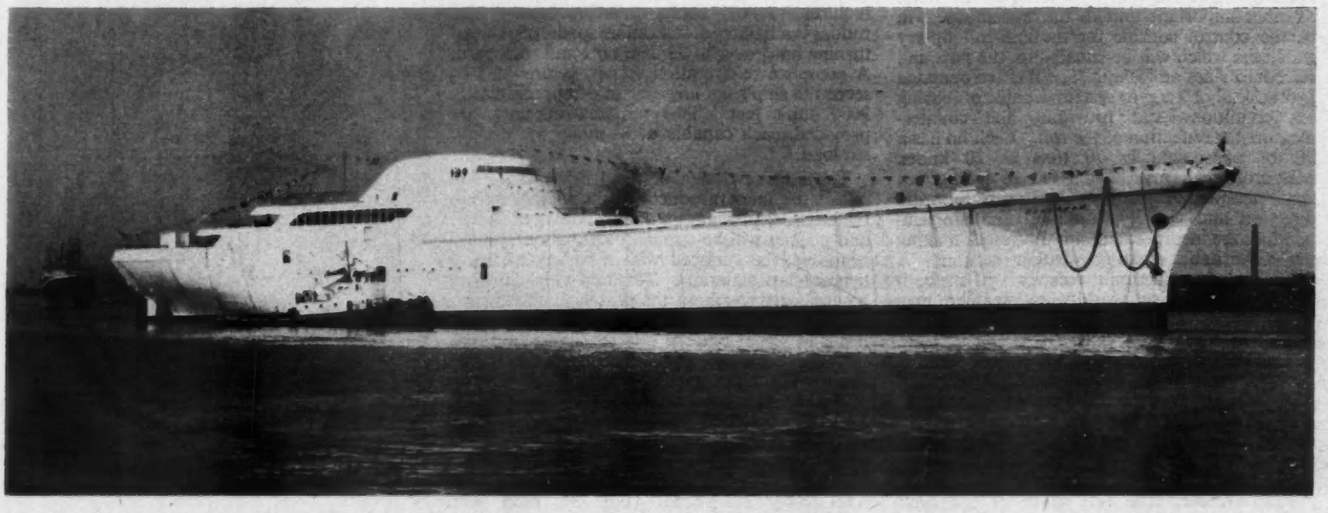


Fig. 1—N.S. "Savannah" after launching into the Delaware River at Camden

division at a draught of 29ft 6in. Her main characteristics are tabulated below:

Length :	
Between perpendiculars, ft	545
Overall, ft	595·5
Beam :	
Moulded beam, ft	78
Draught :	
Fully loaded, ft	29·5
Unloaded, ft	18·5
Displacement :	
Fully loaded, tons	22,000
Unloaded, tons	12,000
Deadweight, tons	9990
Cargo capacity, deadweight, tons	9400
Horsepower :	
Normal, s.h.p.	20,000
Maximum, s.h.p.	22,000
Propeller	Single five-bladed unit
Speed, normal, knots	21
Passengers	60
Crew	About 110
Bale cubic :	
Cubic feet cargo capacity	746,200
Fuel radius, estimated 300,000 nautical miles during period of three and a half years, MWD	52,000

With its modern, sweeping lines, the "Savannah" presents a very attractive profile. Her teardrop-shaped superstructure is set sufficiently aft to enhance the foresection which tapers to its well-raked bow (Fig. 2). This expanse of deck accommodates hatch openings for Nos. 1, 2, 3 and 4 cargo holds which will be served by two sets of cargo gear support trusses and their eight attendant 10-ton booms and cargo handling gear. The cargo handling gear has been specially designed on the basis of the modified Ebel rig and fitted for extremely rapid handling of cargo. Immediately aft of No. 4 cargo hold and forward of the wheelhouse another hatch is situated to provide access to the reactor space. Aft, the superstructure steps down to a generous expanse of deck at the Promenade and "A" deck levels. One set of support trusses equipped with four 10-ton booms serves No. 6 and No. 7 cargo holds. Cargo hatch covers are set in coamings on "A" deck and are of the flush-closing type on "B" and "C" decks. All hatch covers, except for two non-tight, lift-off pontoon covers on the cargo deep tanks in No. 6 hold, are hydraulically operated from local stations at each hatch. The vessel has one additional cargo hold, No. 5, which is served by side ports exclusively.

The uppermost deck, referred to as the navigating bridge deck, serves a dual purpose. The forward end is given over to the pilot house with the wireless room on the starboard side and the chartroom on the port side outboard of the gyrocompass housing. The rest of the navigating bridge deck includes living quarters for three wireless operators and two cadets as well as space for the fan rooms, a battery room, and the emergency generating room. The pilot house is completely outfitted with the latest navigation and communication equipment. Dominating the area is the wheelhouse control console, housing all conventional wheelhouse instrumentation. It is situated well forward and on the centre-line. The magnetic compass is of the reflecting type, the first to be manufactured in the United States. On either side of the steering stand there will be installed the latest navigational radars, utilising "true motion" presentation of data. Another important unit in the wheelhouse will be the control console for the anti-roll Sperry stabilisers which will be situated on the port and starboard sides amidship. The fins are operated hydraulically by a gyro system capable of sensing sea conditions and providing the countermeasure for reduction of the roll. Each fin has a lift of approximately 70 tons at 20 knots. Meteorological instruments for recording sea water temperature, atmospheric pressure, wind direction and velocity, humidity and air temperature are incorporated into the vessel, making her a veritable floating weather station. A special wireless facsimile receiver will make it possible to receive world-wide weather map transmissions at sea from the U.S. Weather Bureau in Washington, D.C.

The boat deck, the next uppermost deck, is devoted entirely to officers' accommodations. A spacious officers' lounge situated in the after-end affords observation on either side of the ship as well as aft overlooking the passenger recreation area. The promenade deck is devoted exclusively to public rooms and spaces. A "walk around," the full width of the deck, comprises a series of windows, 30in high, permitting an unobstructed, yet sheltered, forward view of the sea. Just behind the promenade deck "walk around" is the main lounge which can be closed off from the adjacent writing-room and card-room by folding screens. The main lounge will be equipped with projection equipment for motion pictures as well as for closed-circuit television viewing of the reactor spaces. The after end of the promenade deck structure includes the veranda and cocktail bar, which, through sliding glass doors, opens on to the swimming-pool. The remaining deck space on this level will be utilised as a shipboard game area.

Within the hull structure, the "A" deck level is assigned to the main lobby, passenger staterooms and accommodations for the purser, steward, doctor and nurse. The ship's hospital and dispensary are also situated on this level, as is the health-physics laboratory. All of the public areas on the ship, the passenger staterooms and the passenger's dining-room, are to be completely air conditioned. The vessel has a viewing gallery, on "C" deck, which allows visitors to observe the engine-room from three sides and to look through the large windows of the main engine and reactor control room.

The hull is built on a conventional transverse framing system except for the inner-bottom. The inner-bottom, below the reactor space, is "egg crated" with transverse floors at every frame, and a deep, vertical keel and many keelsons in the fore and aft direction. In addition to this great strength in the inner-bottom, there are two heavy longitudinal collision bulkheads, 21ft 9in off centre-line on the port and starboard sides, adjoining the reactor space. Outboard of the collision bulkheads, "B," "C" and "D" decks have heavier-than-normal plating, continuously welded to the beams. Inboard of these bulkheads are collision mats, extending between "C" deck and the 14ft flat for a length of 35ft adjacent to the central portion of the reactor containment vessel. This mat is made up of alternate layers of steel, 1in thick, and redwood 3in thick, resulting in a total mat thickness of 24in. The additional hull strength ensures very high resistance to collision and grounding. In the event of a broadside collision opposite the reactor space, the ramming ship would have to penetrate 17ft of stiffened ship structure, the heavy collision bulkhead, 2ft of collision mat, 1ft 6in of reinforced concrete shielding and the reactor containment vessel, before the actual reactor plant could be damaged. The high strength of the inner-bottom, together with the very strong supports for the containment vessel, offer tremendous resistance to reactor plant damage due to grounding.

The "Savannah" has four aluminium lifeboats hung from steel gravity davits. One boat is hand-propelled, another is motor-propelled, and two are oar-propelled. They have a total capacity of 190 persons. The ship's steering gear is a four-cylinder, electro-hydraulic ram unit driving the crosshead through a Rapson slide. Two independent power plants are capable of handling the rudder with a maximum torque requirement of about 7,000,000in-lb. The rudder is a balanced, streamline spade, capable of turning hard over to 38 deg. port and starboard. A complete refrigeration system is provided to serve the ship's cooling system of approximately 9000 cubic feet. Two refrigeration units are provided, each capable of handling the normal sea load.

The interior design of the "Savannah" will reflect the finest products of modern American materials, craftsmanship and technology. Metals and plastics will be apparent throughout. Bulkheads will be surfaced with a variety of maintenance-free materials. Textured vinyl film will be applied throughout the passenger staterooms and much of the public room area. The bulkheads of senior officers' quarters and bathrooms will be finished with melamine laminates. Patterned, colour-anodised aluminium will be veneered to bulkheads enclosing the main stairs. Integrally coloured marine veneer will line the passenger corridors. Carpets, draperies and upholstery will utilise a maximum of man-made fibres, such as "Saran," nylon and "Dynel." The thirty staterooms (Fig. 3), each with private bath, accommodate one, two or three

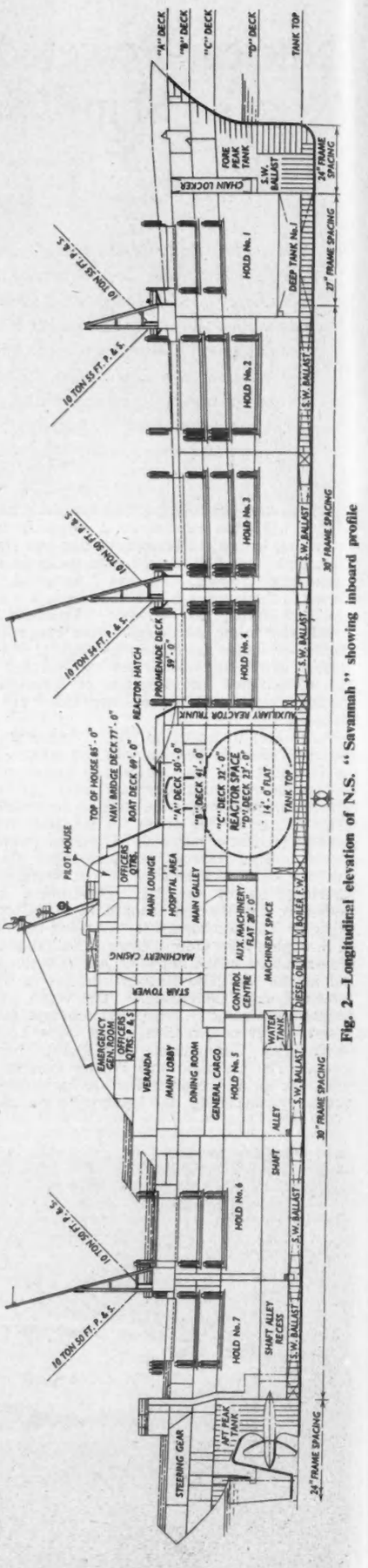


Fig. 2—Longitudinal elevation of N.S. "Savannah" showing inboard profile

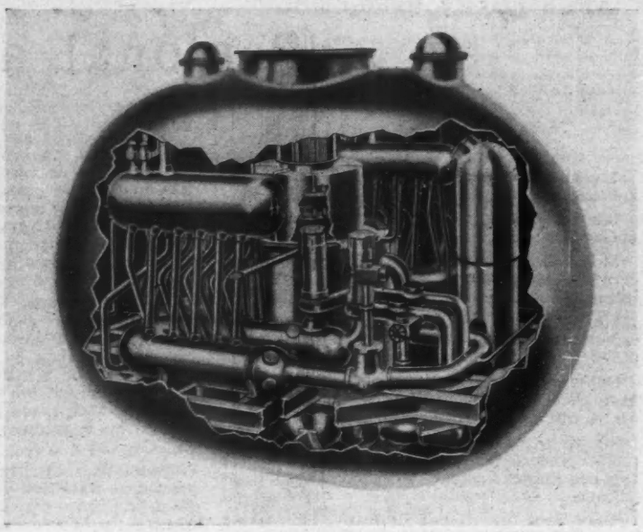


Fig. 3—(Left) Sample stateroom furnished with twin beds. Fig. 4—(Right) Artist's impression of the pressurised water reactor system housed within the containment vessel of the "Savannah"

passengers. Adjoining rooms open up to form two suites. The dining room on "B" deck will seat approximately seventy-five people. The main lounge, situated at the forward end of the promenade deck, is elliptical in shape. On the aft end of the promenade deck, the veranda bar looks out on the swimming pool area through a deck-to-deck glass bulkhead. The dance floor, centred in the room, is outlined with tables whose illuminated tops will glow by means of "panelescence" lighting. The same electro-luminescence will also light the dials of six clocks showing the time in various cities around the world. The enclosed promenade is treated as a terrace and the deck will be covered in ceramic tile of various tones of blue and green. The interior and exterior styling are being executed by the marine specialists, Jack Heaney and Associates, of Wilton, Connecticut.

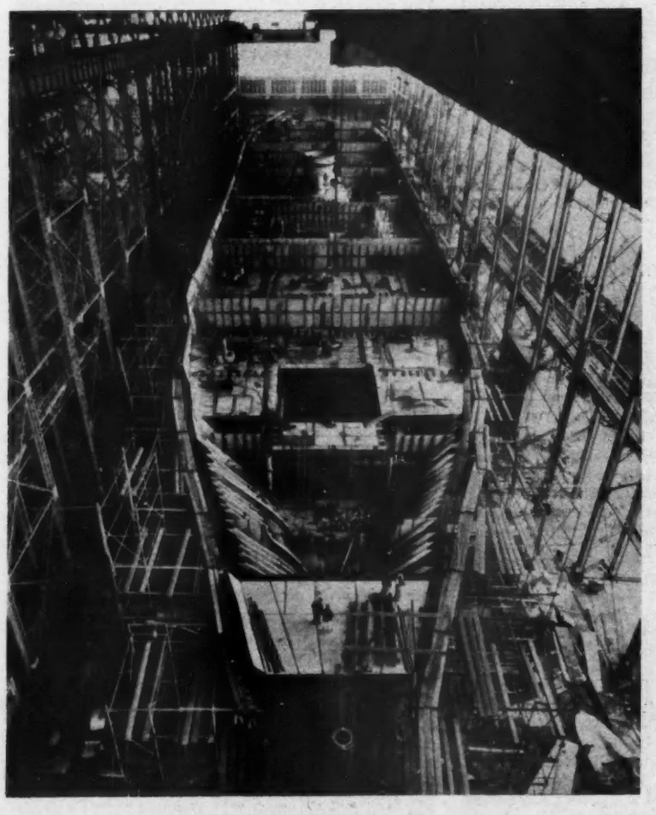


Fig. 5—Erection of the reactor containment vessel amidships between the reactor compartment bulkheads

Nuclear Reactor Plant

The "Savannah" will have one of the most advanced, yet conservatively designed atomic power plants in existence (Fig. 4). It is the same type of pressurised water reactor that has propelled the U.S.S. "Nautilus" on its voyages since 1955, and has been used in the Shippingport Atomic Power Station since 1957. The U.S. Atomic Energy Commission awarded the prime contract for the design and manufacture of the nuclear power plant to the Babcock and Wilcox Company. This firm is also supervising the installation and will participate in the testing of the entire power plant. The steam turbines and reduction gear were sub-contracted to the De Laval Steam Turbine Company.

The vessel has been referred to as a floating laboratory because of the valuable operational data and experience she will supply. Although the basic design and operating criteria for the reactor propulsion system were fixed at the very beginning, a number of significant improvements were incorporated in the plant as it was built. Nuclear engineers have also given thought to a future version incorporating further improvements, some of which may be tested on the vessel after she is in operation.

The "Savannah" has nine watertight subdivisions consisting of seven cargo holds, a reactor compartment, and a machinery compartment. The nuclear propulsion system is subdivided into a reactor system and a steam propulsion system. The steam propulsion system is situated in the 60ft machinery compartment just below the superstructure. It comprises the main turbines and reduction gear, the main condensers, the feed water system, the turbo-generators to supply propulsion auxiliaries and ship's "hotel" load, and the emergency diesel generators and package boiler to supply the ship's emergency needs. To enable visitors to inspect the machinery compartment, a galley is provided at an upper level and the control room will be glass enclosed. The reactor system is situated amidships (Fig. 5), between the bulkheads forming the reactor compartment. The major portion of this system, including the reactor with its primary loops, pressuriser, steam generators, primary circulating pumps, air conditioning system and other auxiliary systems, will be enclosed within a cylindrical containment vessel, centrally situated in this compartment. Certain low pressure reactor system auxiliaries, such as the primary water demineralisers, charge pumps, drain tanks, and a few other components, are situated just outside the containment vessel for reasons of better access or maintenance. The following table gives the general characteristics of the power plant.

Power Plant Performance Data

	Normal	Maximum continuous
Shaft power, s.h.p.	20,000	22,000
Shaft speed, r.p.m.	107	110
Steam pressure at drum (dry, saturated steam), lb per sq. in abs.	490	474
Main condenser vacuum, in Hg	28·5	28·5
Feed water temperature, deg. Fah.	347	343
Steam consumption :		
For main turbines, lb per hour	186,610	205,100
For other uses, lb per hour	55,590	56,360
Total steam generation required, lb per hour	242,200	261,460
Total electrical load, kW	2,200	2,200
Reactor :		
Design power, MW	74	74
Operating power, MW	63·5	69
Design pressure, lb per sq. in abs.	2,000	2,000
Operating pressure, lb per sq. in abs.	1,750	1,750
Primary coolant flow, lb per hour	8,000,000	8,000,000
Primary water temperature rise through reactor, deg. Fah.	22·8	24·8
Primary water mean temperature, deg. Fah.	508	508

The estimated gross weight of the power plant is as follows :

	Short tons
Propulsion system	1265
Reactor system	665
Containment and shielding	2418
Total	4348

The reactor system is composed of a pressurised water reactor, a pressuriser vessel, and two primary coolant loops. Each loop contains two canned motor pumps, one heat exchanger, two check valves, and two stop valves. The heat added to the primary coolant as it flows through the reactor is given up in the heat exchanger. Here the primary water generates low quality steam which is led through risers to a steam drum directly above the heat exchanger. The moisture is removed in the steam drum and dry saturated steam led to the steam main.

(*To be continued*)

Personal and Business

Appointments

MR. H. G. STERN, A.M.I.E.E., has been appointed a director of Londex, Ltd.

MR. J. M. ESCOTT has been appointed chief designer of Goodenough Pumps, Ltd.

MOBIL OIL COMPANY announces the appointment of Mr. Alec Mosley as public relations officer to succeed Mr. Peter Matthews.

MR. G. C. DALE, B.Sc., has been appointed physicist deputy in the nuclear health and safety department of the Central Electricity Generating Board.

DAVY AND UNITED ROLL FOUNDRY, Ltd., Billingham, Co. Durham, announces the appointment of Mr. A. C. Bird as works manager of the roll foundry.

MR. KEITH ALLISON has been appointed industrial rubber products sales manager for the Goodyear Tyre and Rubber Company of India Private, Ltd., at Calcutta.

AMAR TOOL AND GAUGE COMPANY, Ltd., Grove Road, Chadwell Heath, Essex, has appointed Mr. E. G. McLeod as sales representative for the West Country and South Wales.

MR. MAURICE TATTERSFIELD, A.C.A., has been elected to the board of The George Cohen 600 Group, Ltd., following his appointment as financial controller of the group last year.

MR. I. D. CARTER has been appointed commercial manager of Preformations, Ltd., a company of The Plessey Group, specialising in the production of high quality cast permanent magnets and investment castings.

LONDON MIDLAND REGION, British Railways, in connection with plans for speeding up modernisation and electrification work, has established a new planning office under Mr. W. O. Reynolds, former assistant operating officer.

MR. K. NEVE has joined the board of Turner and Newall, Ltd. Mr. Neve has had long service with the Turner and Newall, Ltd., organisation, and is at present the executive director of its subsidiary company, Turners Asbestos Cement Company, Ltd.

OLDHAM AND SON, Ltd., announces that Mr. Orlando Oldham has been appointed assistant managing director of the company. It is also stated that Mr. J. Dowse has been appointed as production director, and Dr. C. D. J. Statham sales director.

AIR COMMODORE N. A. TAIT, O.B.E., M.I.Mech.E., M.Inst.T., A.F.R.Ae.S., has joined the sales staff of Simmonds Aerocessories, Ltd., following his retirement from the Royal Air Force. Air Commodore Tait was, until his retirement, Director of Aircraft Engineering at the Air Ministry.

SMITHS AIRCRAFT INSTRUMENTS, Ltd., announces that Mr. K. Fearnside has been appointed to the board as director of research. Formerly research manager at the company's Cheltenham factory, Mr. Fearnside will continue to have charge of research activities in his new appointment.

THE MINISTER OF SUPPLY has appointed Professor Michael James Lighthill, F.R.S., as director of the Royal Aircraft Establishment, Farnborough, in succession to Sir George Gardner, K.B.E., C.B., D.Sc., who has been appointed to succeed Air Chief Marshal Sir Claude Pelly as Controller of Aircraft at the Ministry in October.

MR. W. E. A. REDFEARN, director, English Steel Corporation, Ltd., deputy managing director, English Steel Forge and Engineering Corporation, Ltd., and director English Steel Rolling Mills Corporation, Ltd., has been appointed chairman of the National Forgemasters' Association in succession to the late Sir Frederick Pickworth.

GEORGE SALTER AND CO., Ltd., announces that Mr. G. E. Masters, general manager of Salterpak Division, has taken on the additional duties of sales manager. Mr. J. Cruise, the previous sales manager, has transferred to head the Research and Development Department. Mr. J. T. Eades has been appointed to represent Salterpak in the Southern counties.

THE EASTERN REGION OF BRITISH RAILWAYS announces the appointment of Mr. J. C. Spark as works manager, Doncaster. In this capacity he will be in charge of the combined locomotive, carriage and wagon works at Doncaster under the recently announced reorganisation of technical departments. The Region also announces the appointment of Mr. P. Gray as works manager, Stratford, in which capacity he will be in charge of the combined locomotive, carriage and wagon works.

GRIFFIN AND GEORGE (SALES), Ltd., announces the following staff appointments: Mr. Edward Bentley has left his post as branch manager at Manchester to take up the senior post of London branch manager; and he has been succeeded in Manchester by Mr. Kenneth Freer, who was buyer at this branch. Mr. James Branson has left his post as Yorkshire representative to become Manchester assistant branch manager.

MR. J. A. DEWHIRST has been appointed managing director of Midgley and Sutcliffe, Ltd. Mr. Dewhirst was appointed a director of the company at the time of its purchase by the 600 Group and has for some years been a local director of George Cohen Sons and Co., Ltd. In future he will devote himself entirely to Midgley and Sutcliffe, Ltd., and has relinquished his appointment with George Cohen Sons and Co., Ltd.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., announces four new appointments in the Heavy Plant Division: Mr. E. C. Barwick, B.Sc.(Eng.), M.I.E.E., becomes manager, large electrical machine engineering (Rugby); Mr. E. E. A. Grace, B.Sc. (Eng.), A.M.I.E.E., becomes manager, medium electrical machine sales; Mr. K. F. Raby, M.A. (Cantab.), A.M.I.E.E., becomes manager, medium electrical machine engineering; and Mr. W. H. Hunt becomes superintendent, medium electrical machines department.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., announces that the following district office appointments were made when the A.E.I. offices took over from the offices of the British Thomson-Houston Company, Ltd., Metropolitan-Vickers Electrical Company, Ltd., and Ferguson Pailin, Ltd., last month. Home district office executive: general manager, Mr. W. A. Ankerson; district office executive, Manchester, Mr. R. S. D. Bagnall; district office executive, Rugby, Mr. K. G. Leach. Regional managers: Scottish, Mr. L. Whitham; North Western, Mr. A. C. Ellis; Northern, Mr. A. J. Crawford; North Midlands, Mr. W. J. Wilson; Midlands, Mr. K. J. Clarke; South Western, Mr. J. S. Hall; and Southern, Mr. E. Mead.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION announces the following changes at Under Secretary level: Mr. C. P. Scott-Malden has become principal establishment and organisation officer in succession to Mr. P. J. E. Dalmahoy, C.B., who is undertaking special duties; Mr. T. F. Bird, C.B., has taken charge of the Rail, Inland Waterways and Road Transport Groups which are being combined; Mr. R. R. Goodison has taken charge of the Aviation Safety and General Group in place of Mr. C. W. Evans, C.B., C.B.E., who is retiring; Mr. B. P. H. Dickinson has taken charge of the Shipping Policy Group in place of Mr. T. F. Bird; Mr. Reep Lintern has taken charge of the Shipping Operations Ports and Planning Group in place of Mr. Dickinson, and Mr. L. S. Mills, who has been promoted to Under Secretary, has taken charge of the Highways Group in place of Mr. Reep Lintern. A second Under Secretary will be appointed to this Group shortly.

Business Announcements

CONCRETE (SOUTHERN), Ltd., has opened a regional office in Bristol at 18A, Park Street, Bristol, 1 (telephone, Bristol 28724).

EDGAR ALLEN AND CO., Ltd., of Sheffield, has been granted the sole licence for the manufacture and sale in this country of Bamag resonance screens.

PHOTOELECTRONICS (M.O.M.), Ltd., has moved to new premises at Oldfields Trading Estate, Oldfields Road, Sutton, Surrey (telephone, FAIrlands 4571).

H. STOCKWELL AND CO., Ltd., has moved to new offices at Trafford Road, Trafford Bridge, Salford, 5. Telephone: Trafford Park 1632, 1633, 1634, 1635.

BRITISH ANZANI ENGINEERING COMPANY, Ltd., announces that Mr. W. H. Coles has left the company, and that Mr. E. F. Ranger is now sole managing director.

D.P. BATTERY COMPANY, Ltd., has moved its London office to 137, Victoria Street, London, S.W.1. The telephone number and telegraphic address remain unaltered.

PANNELL (PLANT), Ltd., Torre Hill, Plymstock, Plymouth, has been appointed agents for the Stothert and Pitt, Ltd., contractors' plant department in the counties of Devon and Cornwall.

BIRLEC, Ltd., has now established a Midland area sales office with Mr. H. J. Podmore as manager. The new office will be situated at the company's main premises in Tyburn Road, Birmingham, 24.

HENRY PELS AND CO., Ltd., announces that, consequent upon an amicable agreement, the machine tool agencies held by K. S. Paul (Machine Tools), Ltd., have been transferred to the company as from July 1, 1959.

ELGAR MACHINE TOOL COMPANY, Ltd., 172-178, Victoria Road, Acton, London, W.3, has been appointed exclusive distributors in the United Kingdom for the range of "Zerbst" heavy duty facing and short bed lathes.

SYKES MACHINE TOOL COMPANY, Ltd., Hythe Works, The Hythe, Staines, Middlesex, announces that it has been granted the agency for Great Britain by Maschinenfabrik Ravensburg A.G. (14b), Ravensburg Wurttemberg, Germany.

HARDY SPICER, Ltd., announces the resignation of Mr. H. P. Oldham from his position of director of manufacturing of the company. Mr. Oldham is a naturalised American citizen and has resigned from the company to return to the U.S.A.

STRAIN AND ROBERTSON announce that they have taken into partnership Mr. W. G. Caldwell, A.M.I.Mech.E., and Mr. W. R. Murray, B.Sc., A.M.I.E.E., both of whom have been members of the firm's staff for a number of years.

BRITISH ROPES, Ltd., announces that from September 1, its Midland region sales office dealing with engineering rope and fittings is being transferred from Doncaster to the company's plant in Denby Dale Road, Wakefield. Mr. R. Stead is in charge of the new office.

RICHARD HILL, Ltd., Middlesbrough, a member firm of the Firth Cleveland Group specialising in the design of reinforced concrete structures and in the manufacture of reinforcement, has set up a design office at 39, Half Way Tree Road, Kingston, in the West Indies, and appointed Mr. A. J. Benghiat, B.Sc., as manager.

THE B.I.P. GROUP has moved to new premises and its new address is British Industrial Plastics, Ltd., Haymarket House, 28, Haymarket, London, S.W.1. Telephone: Trafalgar 3121. The offices also house the London sales offices of two of the Group's subsidiaries: B.I.P. Chemicals, Ltd., and The Streetly Manufacturing Company, Ltd.

WOODS OF COLCHESTER, Ltd., and THERMOTANK, Ltd., announce that the trading association between the two companies under which Thermotank/Woods fans were offered to the marine industry, ceased on August 31. This follows the merger between Thermotank, Ltd., and J. and E. Hall, Ltd. The firms will continue, as formerly, to trade independently.

SIMMONDS AEROCESSORIES, Ltd., Treforest, Glamorgan, member of the Firth Cleveland Group, has entered into licensing agreement with Pryor Manufacturing Company of Mansfield, Ohio, to manufacture "Hydrant" fuel dispensers and general civil and military aircraft refuelling vehicles for world-wide territories, except the American continents.

JOHN LAING AND SON (HOLDINGS), Ltd., announces that the name of the subsidiary company, John and David Martin, Ltd., Lowther Road, Stanmore, Middlesex, has been changed to the Laing Housing Company, Ltd. The change has been made solely to identify the company more closely with the Laing Organisation in the sphere of private housing development.

PYRENE COMPANY, Ltd., Metal Finishing Division, by arrangement with B.B. Chemical Company, Ltd., is now marketing the "Endurion" process as an addition to "Parkerizing" rustproofing finishes for the treatment of ferrous metals. The "Endurion" process is a simple immersion treatment used in conjunction with "Parkerizing" zinc phosphate systems.

BRITISH THOMSON-HOUSTON COMPANY, Ltd., states that after forty-five years' service with the company, Mr. W. J. Pool, B.Sc., A.M.I.E.E., has retired. From 1941 to the end of 1956 he was manager of the industrial engineering department, but relinquished this position in order to study problems associated with nuclear power projects on which the company was engaged.

HAWKER SIDDELEY GROUP, Ltd., and J. LYONS AND CO., Ltd., are planning to join forces to enter the automatic vending business. A joint statement says that the Hawker Siddeley Group, Ltd., has formed a subsidiary company called Primapax, Ltd., with an initial capital of £20,000, which will operate, sell and hire vending machines. Final negotiations are now taking place between representatives of the two firms for an agreement under which Primapax, Ltd., will be owned jointly by them.

MR. A. L. AYTON, F.C.I.S., retired from his position as secretary of Keith Blackman, Ltd., and the Blackman Export Company, Ltd., on August 31, nine days after celebrating his fiftieth year of service with Keith Blackman. He retains his seat on the board of directors of both companies. Mr. E. W. A. Richards, F.C.I.S., has been appointed secretary of both companies, and Mr. A. W. Milborrow chief accountant.

IMPERIAL ALUMINIUM COMPANY, Ltd., announces that its board has now been constituted as follows: from Imperial Chemical Industries, Ltd., Dr. James Taylor (chairman), Mr. Berkeley Villiers (managing director), and Mr. Michael Clapham. From the Aluminum Company of America, Mr. DuBose Avery and Mr. F. J. Resch. It will be recalled that the Imperial Aluminium Company, Ltd. (Impalco), was formed in June when Alcoa and I.C.I. entered into an agreement to collaborate in the manufacture of wrought aluminium products. The I.C.I. aluminium plants at Waunarlwydd are to be transferred to the new company from Metals Division.

WESTLAND AIRCRAFT, Ltd., announces that consequent upon the acquisition of Saunders-Roe, Ltd., certain changes have been made in the respective boards of directors. The Hon. H. N. Morgan-Grenville, O.B.E., chairman of Saunders-Roe, Ltd., Sir Arthur Gouge, B.Sc., and Mr. F. E. N. St. Barbe, have resigned from the Saunders-Roe Board. Mr. Eric Mensforth, C.B.E., F.R.Ae.S., chairman of Westland Aircraft, Ltd., has been appointed chairman of Saunders-Roe, Ltd., and Mr. E. C. Wheeldon, C.B.E., M.I.P.E., managing director of Westland Aircraft, Ltd., has been appointed deputy chairman of Saunders-Roe. The other Westland directors who have joined the Saunders-Roe Board are Mr. D. C. Collins, M.I.Mech.E. (works director, Westland Aircraft), Mr. D. L. Hollis Williams, B.Sc., F.R.Ae.S. (technical director, Westland Aircraft), and Mr. W. Oppenheimer, F.C.A. (finance director, Westland Aircraft). Mr. M. H. C. Gordon, A.F.R.Ae.S., general manager of the helicopter division of Saunders-Roe, has also been appointed to the Saunders-Roe board. Mr. D. C. Collins, M.I.Mech.E., has been appointed works and deputy managing director of Westland Aircraft, Ltd. As previously announced, the Hon. H. N. Morgan-Grenville, O.B.E., and Captain E. D. Clarke, C.B.E., M.C., have joined the Westland board.

Contracts

THE BRITISH STEEL PILING COMPANY, Ltd., has obtained an order for approximately 10,000 tons of steel sheet piling from the Suez Canal Authority. The piling is now being produced by the Appleby-Frodingham Steel Company at its Scunthorpe Works, and will be used for widening the canal over a length of more than 11 miles. The value of the order is about £500,000.

SUBMARINE CABLES, Ltd., has received an order valued at £2,300,000 for 1635 nautical miles of lightweight, co-axial deep-sea cable for the first section of the Commonwealth round-the-world telephone cable. The order was placed by Cable and Wireless, Ltd., on behalf of itself and the Canadian Overseas Telecommunications Corporation, the scheme being jointly financed by these two organisations. Manufacture of the cable will take place at the Greenwich factory of Submarine Cables, Ltd., and it will be laid between Scotland and Newfoundland in the summer of 1961.

STANDARD TELEPHONES AND CABLES, Ltd., has received a contract from the Department of Posts and Telegraphs of the Republic of Ireland for the supply and installation of a 7400 Mc/s microwave radio telephone link between Galway and Athlone; at Athlone the Galway trunks will be interconnected on a through super-group basis to the existing S.T.C. coaxial cable system to provide direct Galway-Dublin trunks. This system will be the first microwave radio telephone link in the Republic. The equipment to be supplied also includes antenna towers at the Galway and Athlone terminals and at the repeater station at Cappataggle, frequency multiplex equipment at the terminals, transmission test equipment and machines for the stand-by power supply. There will be two bothway r.f. channels, one to be used as a standby, each with a capacity of 240 telephone circuits.

Miscellanea

CORRECTION.—In the list of appointments in our issue of August 14 last, it was stated that Mr. J. R. Bergne had been appointed as assistant managing director of Ruston and Hornsby, Ltd. This should have read Mr. J. R. Bergne-Coupland.

MACHINE TOOL DISPLAY IN BIRMINGHAM.—The Elgar Machine Tool Company, Ltd., 172–178, Victoria Road, Acton, London, W.3, has arranged a display of British and Continental machine tools which is to be held at the firm's Birmingham showrooms—1075, Kingsbury Road, Erdington—from October 5 to 10 next.

WELDABLE PRIMER FOR METAL.—A priming coat for steel which has been introduced by Cellon, Ltd., Kingston-upon-Thames, Surrey, enables an electric arc to be struck for welding without need for prior removal of the protective paint. It is stated to have no adverse effect on the strength of a weld and fluxing properties which facilitate removal of slag after welding. The paint can be applied by brush, spray or dip methods and can be covered if required by any normal undercoating or finishing paint.

ROAD RESEARCH LABORATORY LECTURES.—Two lectures will be given this month by Professor J. H. Mathewson, of the Institution of Transportation and Traffic Engineering, University of California, at the Road Research Laboratory, Langley Hall, Langley, Slough, Bucks. On September 9 his subject will be "Experiments on Automobile Collisions," and on September 16 "A Simulator for Research on Driver Behaviour." Both lectures will begin at 3.30 p.m. Tickets for admission can be obtained (gratis) on application to the Director of Road Research, Road Research Laboratory, Harmondsworth, West Drayton, Middlesex.

INDUSTRIAL WELFARE SOCIETY.—The thirty-eighth week-end conference for foremen and forewomen has been organised by the Industrial Welfare Society for October 23-26 at the Palace Hotel, Southport, when the theme will be "The Broader Aspects of Foremanship." Subjects for discussion include discipline, health, work study, communication of ideas, and modern management. Details are obtainable from the Administrative Officer, Industrial Welfare Society (Inc.), Robert Hyde House, 48, Bryanston Square, London, W.1. Other arrangements of the Society for October include courses on "Industrial and Factory Law" (October 20–22), and "Increasing Efficiency and Improving Work Relations" (October 26–30). Both the latter will be held at Robert Hyde House.

ILLUMINATING ENGINEERING SOCIETY LECTURES.—A special series of lectures in connection with the Golden Jubilee of the Illuminating Engineering Society will take place in London during October. The lectures are intended primarily for non-members of the society and admission will be by ticket only, which may be obtained from the society at 32, Victoria Street, London, S.W.1. Applicants should state the lectures for which the tickets are required. Details are as follow: Thursday, October 15, "The Nature of Light," by Sir Lawrence Bragg, at the Royal Institution, Albemarle Street, W.1; Monday, October 19, "The Generation of Light," by Mr. L. J. Davies, at Caxton Hall, Caxton Street, Westminster, S.W.1; Thursday, October 22, "Light and Road Safety," by Dr. W. H. Glanville, at the Institution of Civil Engineers, Great George Street, S.W.1; Tuesday, October 27, "Light and Productivity," by Mr. A. N. Irens, at the Federation of British Industries Tothill Street, S.W.1.

Launches and Trial Trips

DAHRA, wine tanker; built by Anciens Chantiers Dubigeon for the Societe Anonyme de Gerance et d'Armement; length between perpendiculars 316ft 7in, breadth moulded 47ft 11in, depth to main deck 22ft 4in, draught loaded 19ft 6½in, deadweight 4250 tons, trial speed 12·4 knots; Fiat Mk. C.526T.S. diesel engine, 3150 h.p. at 170 r.p.m. Trial, June.

BEN MEDIE, trawler; built by John Lewis and Sons, Ltd., for Messrs. R. Irvin and Sons; length between perpendiculars 135ft, breadth 26ft 6in, depth moulded 13ft 3in, fish room capacity 9000 cubic feet, aluminium alloy equipment; electric trawl winch, 175 b.h.p. motor, 1000 fathoms of 3in warp on each barrel; Mirrlees K.S.S.D.M.7 diesel engine, 854 b.h.p at 225 r.p.m. Trial, June 30.

SAN CALISTO, oil tanker; built by the Furness Shipbuilding Company, Ltd., for the Eagle Tanker Company, Ltd.; length between perpendiculars 630ft, breadth moulded 87ft, depth moulded 45ft 6in, Summer draught 34ft 2½in, deadweight 31,725 tons; thirty oil cargo tanks, one cargo oil pump room, four turbo-centrifugal 900 tons per hour cargo oil pumps, four vertical steam 150 tons per hour stripping pumps; suction and discharge lines, 13½in bore; two 600kW turbine-driven alternators, one 200kW diesel-driven alternator; two Foster Wheeler "D" boilers supply steam at 600 lb per square inch and 850 deg. Fah. to a set of Metropolitan-Vickers double-reduction geared turbines, 12,500 normal shaft horsepower at 105 propeller revolutions per minute, 13,750 maximum shaft horsepower at 108 propeller revolutions per minute, trial speed 15½ knots. Trial, June 29.

MOUNTWOOD, passenger ferry; built by Philip and Son, Ltd., for the Birkenhead Corporation; length between perpendiculars 142ft 6in, breadth moulded 39ft, depth moulded 12ft 6in; 1200 passengers, Steam 5 Certificate; two Crossley H.R.N.8 diesel engines, each of 680 b.h.p. at 350 r.p.m. Launch, July 6.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

ASSOCIATION OF PUBLIC LIGHTING ENGINEERS

Tues. to Fri., Sept. 15 to 18.—Music Hall, Union Street, Aberdeen, Annual Conference.

BRITISH INSTITUTE OF MANAGEMENT

Mon., Sept. 21.—Recital Room, Royal Festival Hall, London, One-day Conference on "Knowing Your Customer," 9.30 a.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 30.—LONDON BRANCH: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Modern Microwave Valves: A Survey of Evolution, Principles of Operation and Basic Characteristics," W. E. Willshaw, 6.30 p.m. ★ TREFOREST BRANCH: Glamorgan College of Technology, Treforest, Glam, "The Use of Demonstration Equipment in Basic Radio Theory," H. Henderson, 6.30 p.m.

INDUSTRIAL WELFARE SOCIETY

Wed., Sept. 16.—Robert Hyde House, 48, Bryanston Square, London, W.1, "Changes in Industrial Law—The New Factories Act Explained," H. Samuels, 2.30 p.m.

Mon., Sept. 28.—Robert Hyde House, 48, Bryanston Square, London, W.1, "Changes in Industrial Law—The New Factories Act Explained," H. Samuels, 2.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Sept. 23.—Constitutional Club, Northumberland Avenue, London, W.C.2, First Meeting of the 1959/60 Session, 7 p.m.

INSTITUTE OF PHYSICS

Wed. to Fri., Sept. 16 to 18.—STRESS ANALYSIS GROUP: The University, Birmingham, Annual Residential Conference.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., Sept. 23.—YORKSHIRE BRANCH: Midland Hotel, Bradford, Yorks, "Stress Analysis as Applied to Design," J. Ward, 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., Sept. 22.—Grand Council Chamber, The Federation of British Industries, 21, Tothill Street, Westminster, London, S.W.1, General Meeting: Presidential Address, R.A. Smeddle, 5.30 p.m.

INSTITUTION OF PLANT ENGINEERS

Tues., Sept. 8.—EDINBURGH BRANCH: 25, Charlotte Square, Edinburgh, Members' Evening, 7 p.m. ★ MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, Chairman's "At Home," 7.15 p.m.

Wed., Sept. 9.—DUNDEE BRANCH: Taypark Hotel, West Ferry, Dundee, "Air Cooled Diesel Engine Development," P. L. Johnson, 7.30 p.m. ★ WESTERN BRANCH: Royal Clarence Hotel, Cathedral Close, Exeter, "Glass in Industry," 7.15 p.m.

Thurs., Sept. 10.—NORTH-EAST BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, "The Wilston Project," G. C. Lanham, 7 p.m.

Wed., Sept. 16.—KENT BRANCH: Kings Head Hotel, High Street, Rochester, "Industrial Law and the Engineer," R. Cambridge, 7 p.m.

Thurs., Sept. 17.—BLACKBURN BRANCH: Castle Hotel, Blackburn, Joint Meeting with the Institute of Fuel, "Films and Lectures," E. A. Taylor, 7.30 p.m.

Tues., Sept. 22.—SOUTH WALES BRANCH: South Wales Engineers' Institution, Park Place, Cardiff, Technical Films, 7.30 p.m.

Thurs., Sept. 24.—GLASGOW BRANCH: Scottish Building Centre, 425/427, Sauchiehall Street, Glasgow, "Basic Electronics in Industry and Commerce," R. H. Garner, 7.15 p.m. ★ MERSEYSIDE AND NORTH WALES: Exchange Hotel, Liverpool, "Mounting and Maintenance of Roller Bearings," E. Taylor, 7.15 p.m. ★ NORTH-EAST BRANCH: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "The History and Development of Rotary Air Compressors," 7 p.m. ★ SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "Rolling Plant," P. A. Clark, 7.30 p.m.

Fri., Sept. 25.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Works Engineering," R. T. Wells, 7.30 p.m.

Mon., Sept. 28.—WEST AND EAST YORKSHIRE BRANCH: Houldsworth School of Applied Science, The University, Leeds "Operational Research," G. D. Jordan, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Sept. 7.—COVENTRY GRADUATE SECTION: Webster and Bennett, Northy Road, Coventry, "Specialised Manufacture of Vertical Turning and Boring Mills, 6.45 p.m.

Wed., Sept. 9.—LIVERPOOL GRADUATE SECTION: Lecture Hall, Y.M.C.A., Mount Pleasant, Liverpool, "Quality Control," W. MacCrimmon, 7.30 p.m. ★ LONDON GRADUATE SECTION: 10, Chesterfield Street, Mayfair, London, W.1, "Why Not Tool in Plastics?" P. G. Pentz, 7.15 p.m.

Mon., Sept. 14.—SHEFFIELD GRADUATE SECTION: Rothervale Manufacturing Company, Ltd., Woodhouse Mill, Near Sheffield, "Production Joinery," 6.45 p.m.

Thurs., Sept. 17.—WOLVERHAMPTON GRADUATE SECTION: Works Visit to Joseph Lucas, Ltd., Great King Street, Birmingham, 2 p.m.

Thurs., Sept. 24.—HALIFAX AND HUDDERSFIELD SECTION: Visit to T. S. Harrison and Sons, Ltd., Union Street, Heckmondwike, 6.30 p.m.

Wed., Sept. 30.—SHREWSBURY SECTION: Technical College, Shrewsbury, "Uses and Developments of Work Study," W. C. Castledine, 7.30 p.m. ★ LOUGHBOROUGH COLLEGE STUDENT SECTION: Visit to J. Lucas, Ltd., S. Block Restaurant, Farm Street, Hockley, Birmingham, 2 p.m.

NATIONAL ASSOCIATION OF DROP FORGERS AND STAMPERS

Wed., Sept. 16.—Botanical Gardens, Birmingham, One-day Symposium on "Spark Machining."

PHYSICAL SOCIETY

Mon. and Tues., Sept. 14 and 15.—Department of Natural Philosophy, The University, Edinburgh, Conference on "Nuclear Physics," 9.30 a.m.

Thurs. and Fri., Sept. 17 and 18.—Imperial College, The University of London, Conference on "The Physics of Very High Temperatures," 9.30 a.m.

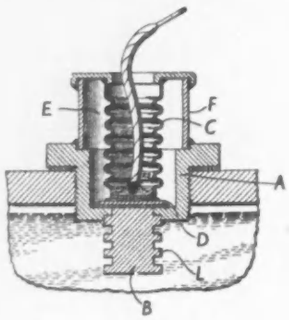
British Patent Specifications

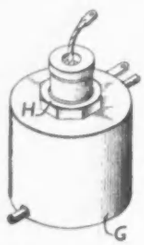
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ELECTRICAL ENGINEERING

812,999. November 20, 1956.—RECTIFIER UNITS, Texas Instruments Incorporated, 6000, Lemmon Avenue, Dallas, Texas, United States of America. (*Inventors: Jay Wesley Thornhill and Edmond Donald Jackson.*)

The heat dissipation of a rectifier is recognised as being a limiting factor with respect to the current load carrying capacity of a particular unit. According to the present invention, a rectifier unit is characterised by a cooling system whereby the unit can be operated at high current loads and when so operated will not be subjected to excessive temperatures which otherwise would cause a breakdown. The drawing shows a cross section through such a rectifier unit. The bottom of the base section *A* has a central hole in which is received a cooling element *B*, preferably made of copper, aluminium, brass or other material having a high thermal conductivity. The cooling element is soldered to the bottom of the base section. Positioned between the bottom of bellows *C* and the top of the cooling element is a rectifier element *D*. One example of a suitable rectifier element would





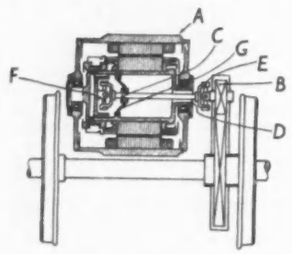
No. 812,999

be a germanium-indium wafer. A layer of solder attaches the top surface of the wafer to the bottom of the bellows and, similarly, a layer of solder attaches the bottom surface of the wafer to the top of the cooling element. Hence a laminated construction is provided with the bellows connected to it so as to provide freedom of movement of the laminated construction in a vertical sense due to thermal expansion. At the same time, the bottom of the laminated construction is in direct heat exchange relationship with the top surface of the cooling element and the bottom of the base section so that exceedingly good heat dissipation will be obtained. An annular space *E* is defined between the bellows, on the one hand, and the base section and annulus *F* on the other. This annular space is completely sealed from the atmosphere and is preferably filled with an inert gas such as nitrogen or helium. Accordingly, the rectifying elements will be sealed from the atmosphere and will function solely in the inert medium. The unit as described is shown in the second drawing mounted on to a tank *G* which has a threaded opening in its upper surface. For purposes of sealing the unit against fluid leakage, a lead gasket underlies the flange *H*, which provides a good electrical contact as well. The tank is provided with an inlet pipe and an outlet pipe, whereby a cooling medium can be circulated through the tank around the cooling element *B* and more specifically around the cooling fins *L*. It has been found that a rectifier unit, constructed according to the principles of the present invention, when operated, is capable of carrying a current load of 100A or more while dissipating efficiently heat generated incident to operation.—*May 6, 1959.*

ELECTRIC TRACTION

812,931. January 4, 1956.—FLEXIBLE DRIVE FOR ELECTRIC RAILWAY VEHICLES, Zavody V.I. Lenina, Narodni Podnik, of Plzen, Czechoslovakia, Savelij Chadzi, of Plzen, Czechoslovakia, and Jan Sieber, of Plzen, Czechoslovakia.

The present invention relates to the transmission of torque from a frame-mounted or bogie-mounted traction motor to the axle of an electric railway vehicle. The invention is characterised by a piston-like member arranged in a cylindrical cavity of the machine rotor or pinion so that it is free to move axially but follows the rotation of the member which



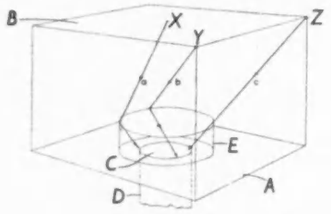
No. 812,931

forms the cavity. Referring first to the drawing showing one embodiment of the invention, the torque produced by the motor *A* is transmitted to the pinion *B* of the gearing by means of a drive shaft *C* which is located within the cavity of the rotor shaft and extends at one end to the outside through the hollow journal *D*. The outer end of the torsion rod is connected through a universal joint *E* to the pinion, and its inner end is connected likewise through a universal joint to a piston-like member *F* which is splined at its circumference, i.e. provided with axially extending grooves which are engaged by complementary axially extending splines projecting inwardly from the cylindrical rotor shaft to form a multiple spline coupling. Thus the member is free to slide in an axial direction and, due to its large diameter, the specific pressure in the multiple spline coupling will be small so that the stress to which this coupling is subjected is small and the sliding movement is not impeded. To reduce still further the friction in the sliding spline coupling during operation, the part of the cylindrical cavity of the shaft in which the member is located, is sealed by means of a membrane *G* so that an enclosed chamber is formed which may be filled with lubricating oil. Other embodiments illustrated in the specification show the piston-like member housed in a cavity formed by the pinion, and in a hollow extension of the pinion shaft.—*May 6, 1959.*

ELECTRONICS

813,098. May 6, 1957.—SCINTILLATION DETECTORS, Mullard, Ltd., Spencer House, South Place, Finsbury, London, E.C.2. (*Inventor: Jeremy David Cook.*)

The use of scintillation counters having a large phosphor screen area has given rise to a disadvantage in that the amount of light incident upon the photo-multiplier tube is dependent on which part of the phosphor is emitting the light. Thus, equal light effects at the centre and corners of the phosphor screen give rise to different electric currents in the photo-multiplier tube. It is an object of the present invention to provide an improved scintillation



No. 813,098

detector in which the above disadvantages are mitigated in a simple and relatively inexpensive manner. The drawing shows diagrammatically the rectangular light-tight chamber *A* of a scintillation detector. The inner surface of the upper rectangular face *B* is constituted by a phosphor screen which has an outer backing of thin aluminium foil which renders this face light-tight. The remaining faces are of metal and in the centre of the lower rectangular face opposite the phosphor screen is arranged the end-window *C* of a photo-multiplier tube *D*. The light-sensitive cathode of the photo-multiplier tube may be in the form of a coating on the inside of the window or it may be separate and spaced a short distance from the window. Adjacent the window *C* and coaxially therewith is arranged a right-cylinder *E* of aluminium having its internal and external surfaces polished. The metal walls of the chamber are painted to give a white matt finish. The ideal relative dimensions of the cylinder, chamber, screen and window are illustrated by means of the rays *a*, *b* and *c*. The ray *a* illustrates that light from a scintillation occurring at *X* in the centre of the screen is now reflected by the inner surface of the cylinder on to the window of the photo-multiplier tube. Rays *b* and *c* from scintillations occurring at the corners *Y* and *Z*, respectively, of the chamber illustrate that light from these points is incident upon the photo-cathode both directly (ray *c*) and also by reflection (ray *b*).—*May 6, 1959.*

CEMENT

813,084. September 2, 1957.—CEMENTS FROM GRANULATED BLAST FURNACE SLAGS, Société Financière de Transports et D'Entreprises Industrielles (Sofina) Société Anonyme, 38, rue de Naples, Brussels, Belgium.

It is well known that granulated blast furnace slags, although they contain the compounds usually found in water-mixed binders, namely calcium silicates and aluminates, when finely powdered and mixed with water have no normal set similar to that of cements. The inventor of this process concluded that this is due to the immediate formation of a silicic acid gel which surrounds the grains of slag, thus hindering any further hydration. If, however, the paste of slag and water is violently shaken for some time, a more or less normal set takes place but the removal of the gel by mechanical means in the presence of water obviously cannot be made use of in practice. The present invention allows removal of the gel or hindering of its formation by the addition of certain substances. According to the invention, cements of high early strength increasing progressively with time comprise a high proportion of finely ground granulated blast furnace slag mixed with a small proportion of anyhydrous sodium sulphate (about 4 per cent) and a small portion of either hydrated lime (about 2 per cent) or Portland cement clinker (about 5 per cent) which provides by hydrolysis the required quantity of lime to start the reactions of setting and hardening when the cement is mixed with water. When the above specified substances are present the slag acquires a normal set and hardens rapidly. This shows that the inhibiting action of the gel has been removed so that the normal reactions of hydration of the anhydrous components of the slag can proceed, and furthermore, the use of sodium sulphate is believed to result in the formation of a calcium sulpho-aluminate double salt with constituents of the slag which improves the mechanical strength of the cement. Only small quantities of the substances in question are required so that the cement contains a large quantity of slag. —*May 6, 1959.*

METALLURGY

812,985. June 19, 1957.—ALUMINIUM ALLOYS, United Kingdom Atomic Energy Authority, London. (*Inventors: Roy Alfred Ulfketel Huddle, Nigel John Murray Wilkins and Colin Frederick Britton.*)

This invention has as its object an improvement in the resistance of aluminium-nickel alloys to corrosion by water at high temperatures and pressures. It is known that alloys of aluminium containing 0·5 to 5 per cent nickel, and preferably also 0·25 to 1 per cent iron, have an improved resistance to such corrosion compared with pure aluminium. It is believed that nickel affords protection to aluminium by reducing hydrogen diffusion damage to the latter. Nickel has a low solubility in aluminium, forms a phase from which hydrogen is readily liberated, and is uniformly distributed as small particles throughout the aluminium. It thus provides a uniform distribution of areas of low hydrogen overpotential and allows cathodically produced hydrogen to be evolved freely from such areas on the surface of the metal, rather than to diffuse into it. It has now been found that the corrosion resistance of aluminium can be further improved by an addition of a metal which improves the properties of the protective film itself, formed on the aluminium base by corrosive attack. It is found that additions of less than 0·3 per cent of titanium, alone or together with less than 0·1 per cent beryllium have this desired effect. The invention consists in aluminium alloys containing 0·5 to 2·5 per cent nickel, and 0·1 to 0·3 per cent titanium, the remainder being aluminium or an alloy of aluminium with the well-known alloying additions for high strength, namely, 0·1 to 1 per cent iron, and 0·05 to 0·5 per cent silicon. The alloy may also contain 0·005 to 0·10 per cent beryllium.—*May 6. 1959.*

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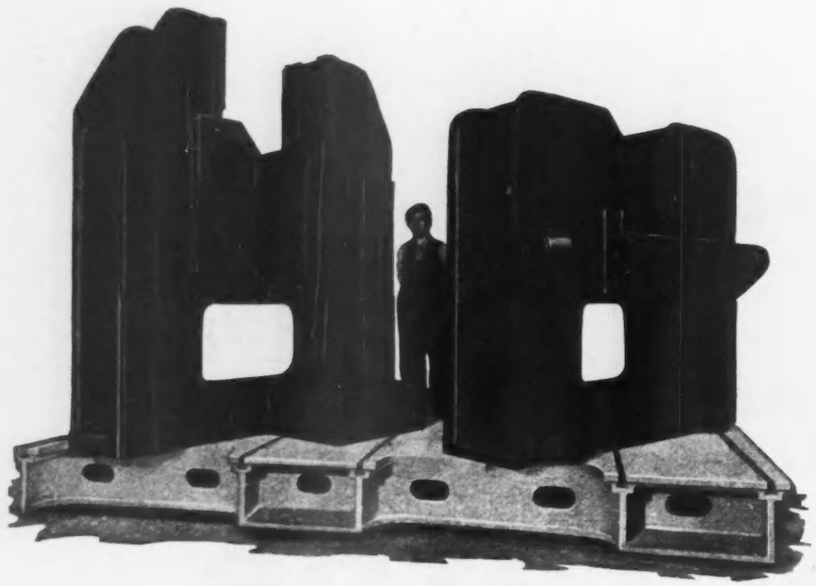

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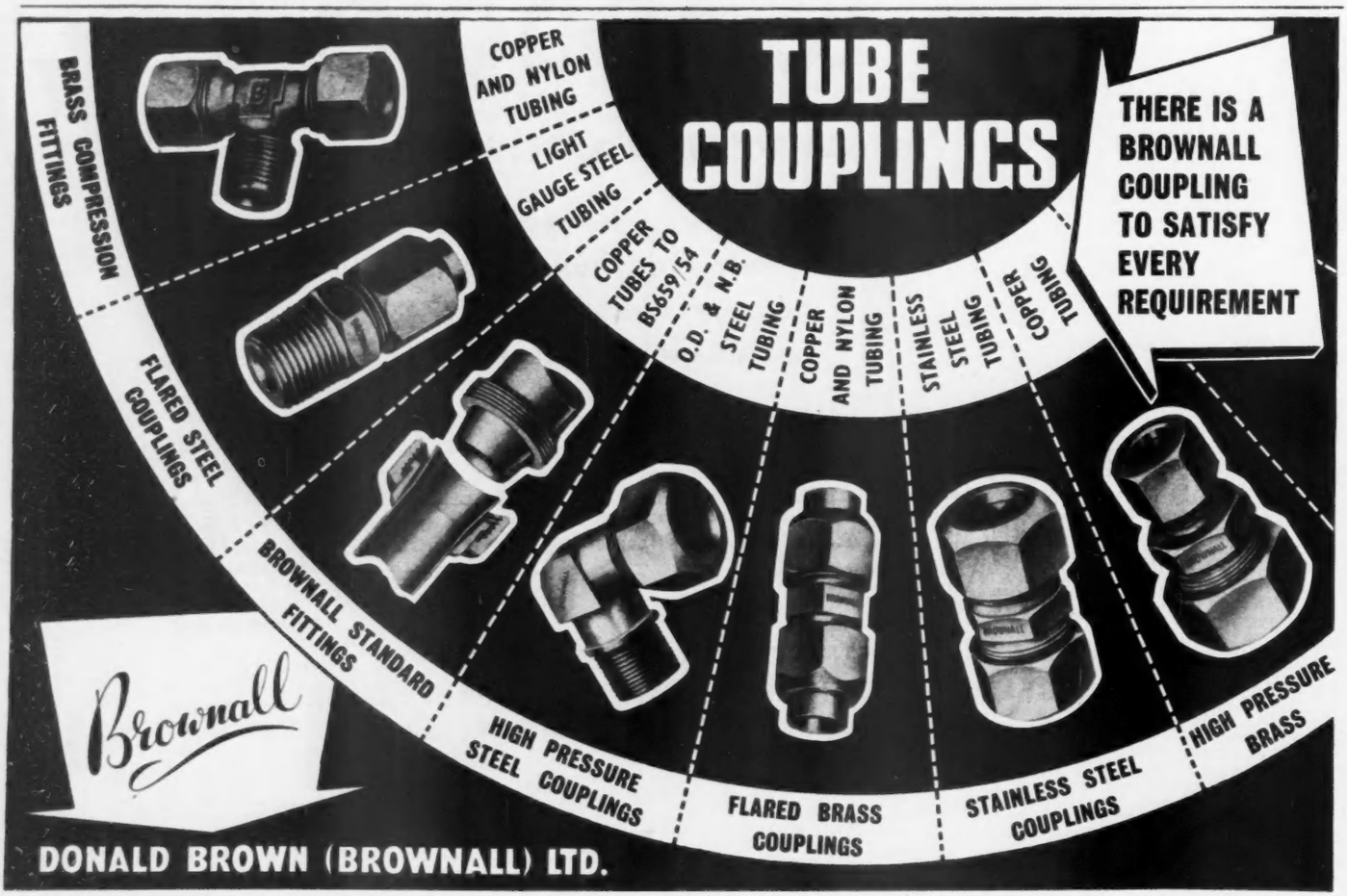

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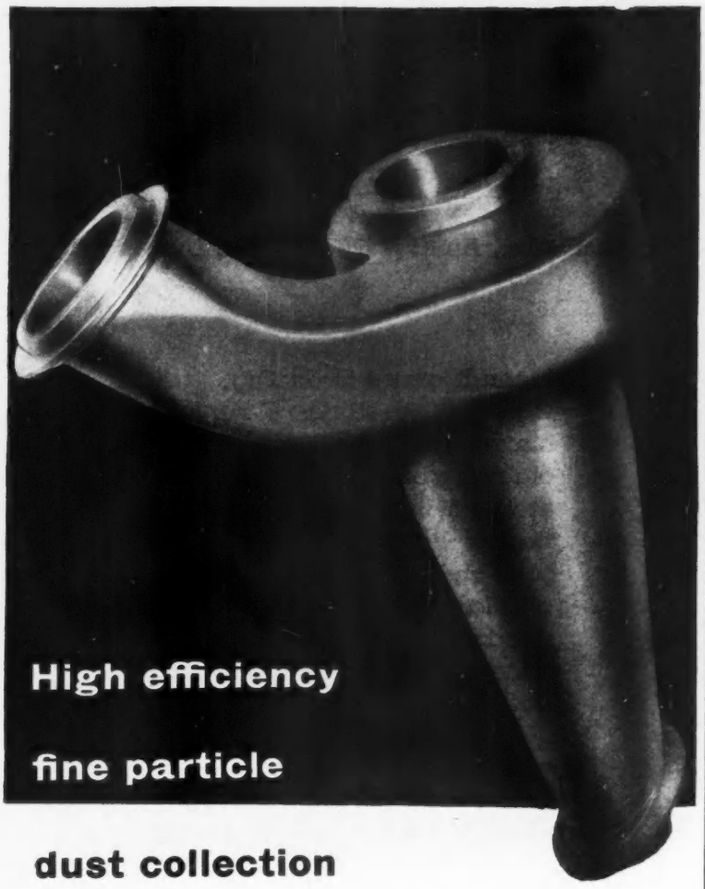

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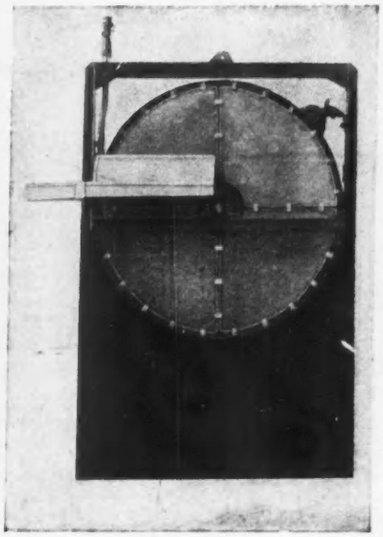

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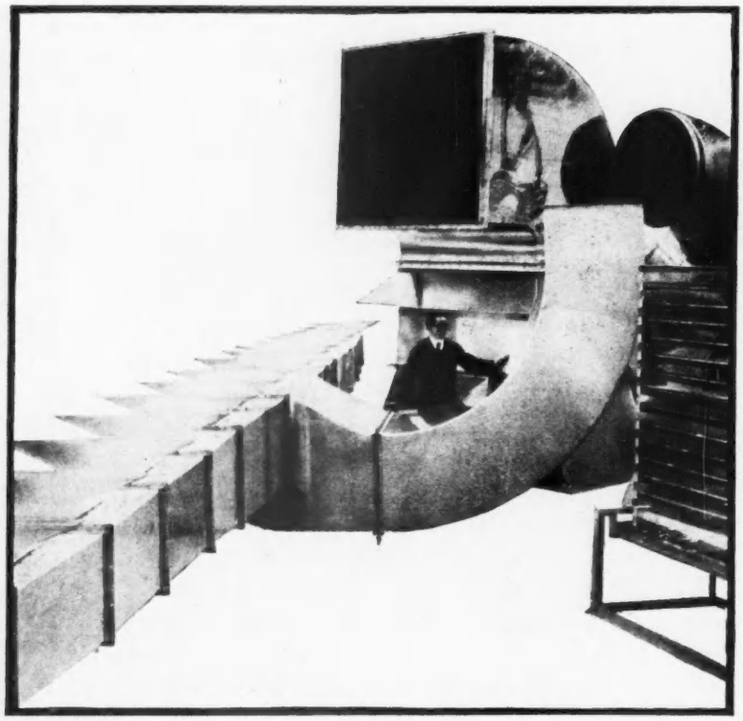

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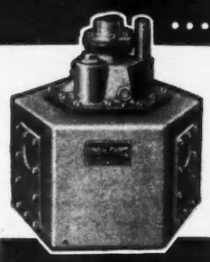

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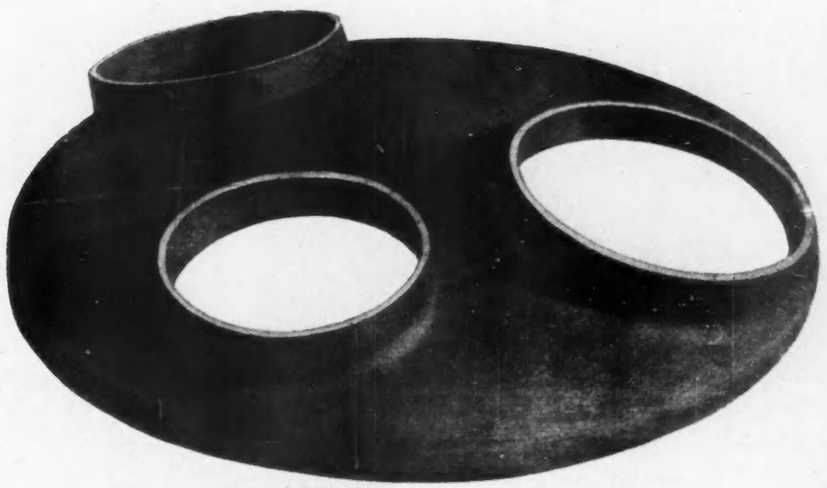

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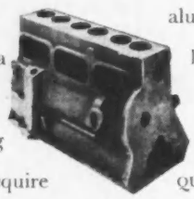

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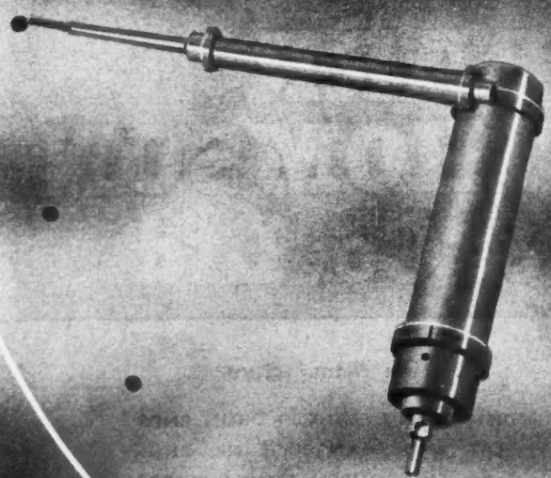

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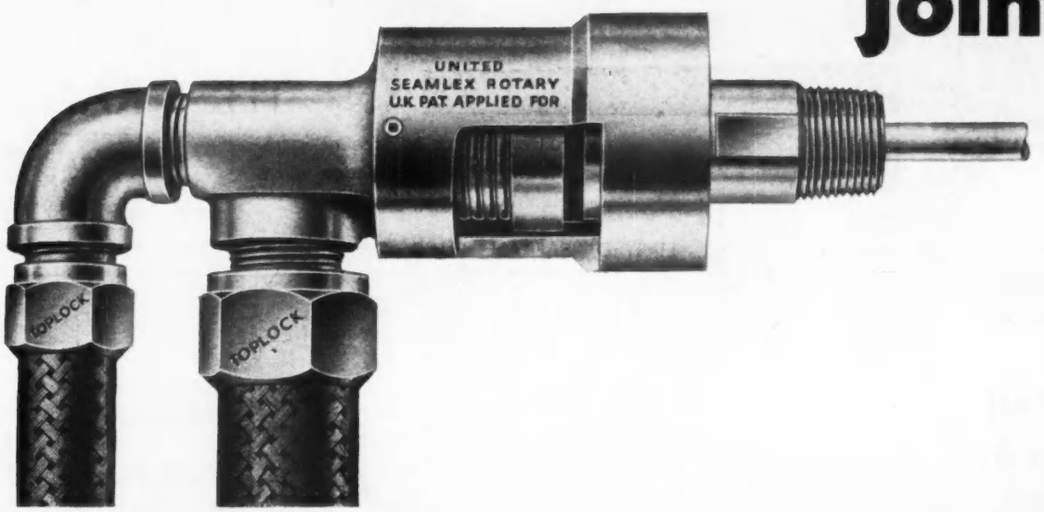

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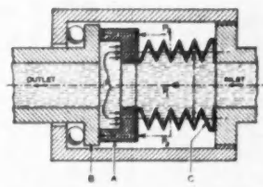


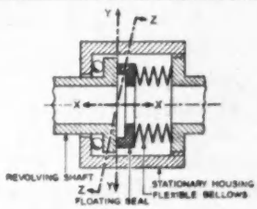
PRESSURE DIAGRAM

How working pressure P_1 + spring (Bellows) pressure P_2 is reduced by counterpressure P_3.

2

FLOATING GRAPHITE SEAL

The Seamlex *Floating* Seal, being flexibly mounted by means of a metallic bellows, is self-aligning, permitting it to move freely in any direction, axially as well as radially and obliquely. The *Floating* Seal absorbs smoothly the impact that is exerted upon it by a misaligned revolving shaft.



FLOATING SEAL

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3

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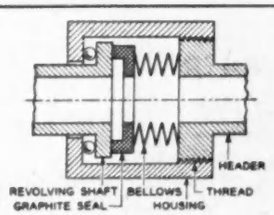

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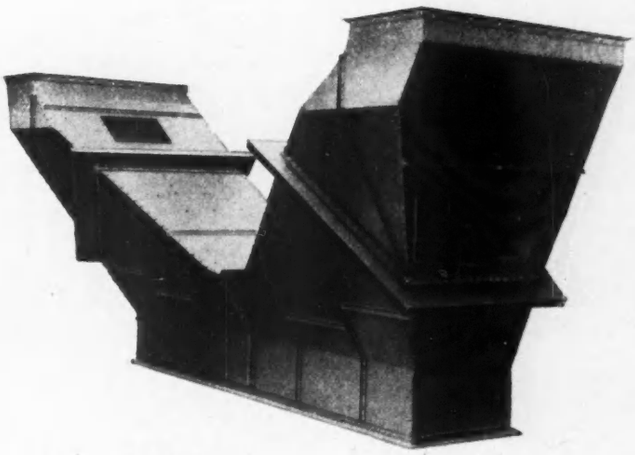

DUCTS

Ducts of rectangular design for power stations or boiler houses, of electrically-welded construction in Mild or Special Steels or Aluminium Alloy, can also be supplied. They are accurately fabricated to suit your exact requirements.

● *Our latest Brochure "FABRICATED PLATEWORK" fully describes our activities in this field. A copy is yours on request.*

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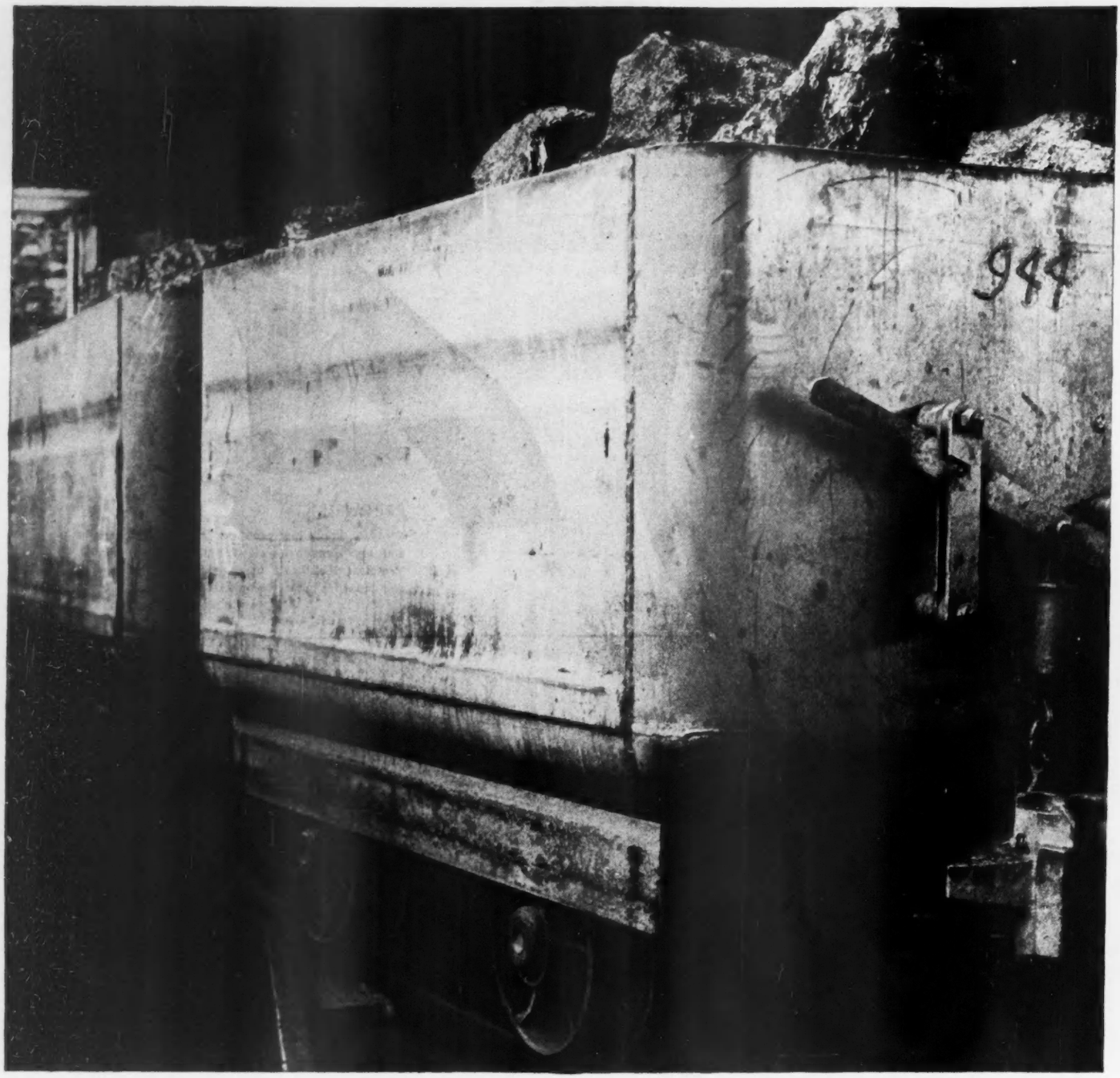

Mine cars made from SCW Cor-Ten (Photograph by courtesy of the National Coal Board)

OPERATION • MAINTENANCE • DEPRECIATION

COR-TEN CUTS THE COST

Where advantage can be taken of its high yield strength and corrosion resistance, SCW Cor-Ten can always effect a substantial cost saving.

Whatever the application (and the range continues to grow) SCW Cor-Ten is able to offer an unchallengeable combination of economy and efficiency.

COR-TEN SAVES MONEY

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Please write to us at the address below for further information or for technical assistance in the application of SCW Cor-Ten to your products

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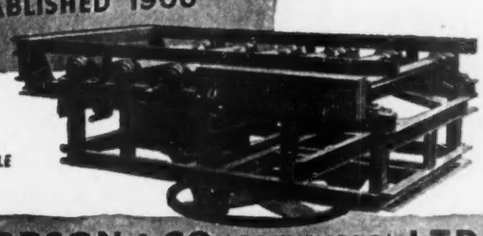

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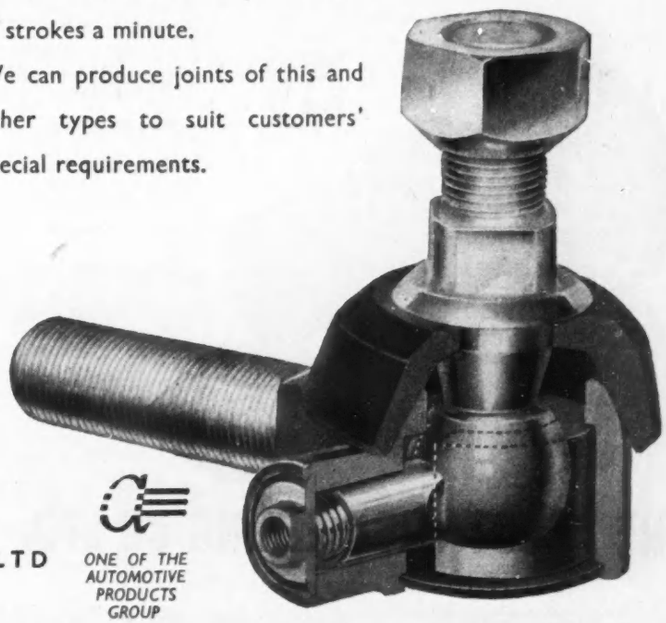
A SPECIAL-PURPOSE JOINT

The illustration shows a 1" eccentric-type self-adjusting joint. This forms the crank-pin and big-end bearing of a crank operating the cutter bar of a mower, at many hundreds of strokes a minute.

We can produce joints of this and other types to suit customers' special requirements.



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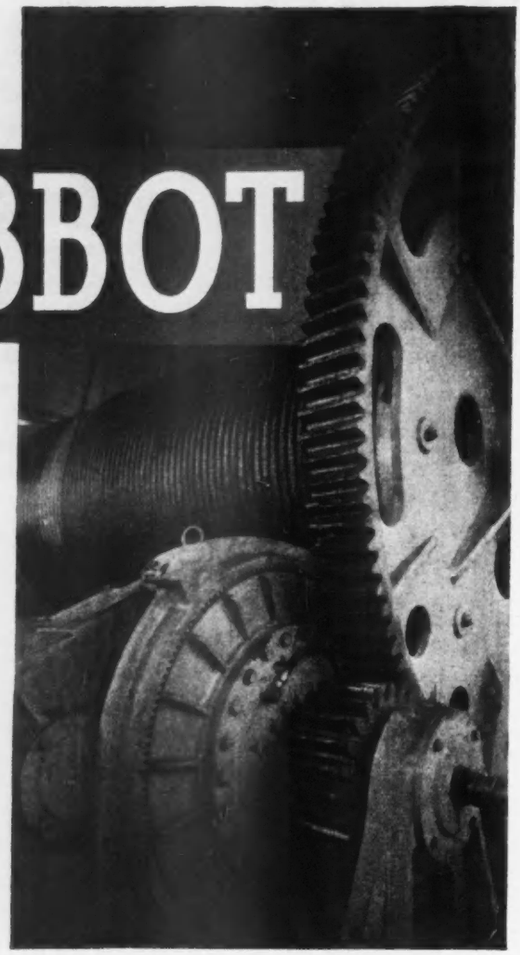

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We guarantee the teeth of all wheels cut by us to be correct, and all work is examined and checked before being despatched. Each gear wheel of a pair is run in correct relative position to the other in a special gear-testing machine.

Our booklet "MACHINE CUT GEARS" contains much information of interest and use to engineers. A copy will be sent on request.

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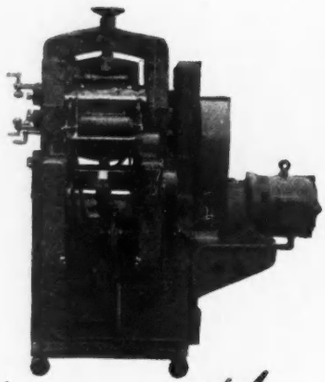

Talk it over with

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Our advisory service can also assist in adapting existing machinery for special purposes, and security is an essential feature of our services—customers can present us with their problems in ABSOLUTE CONFIDENCE.

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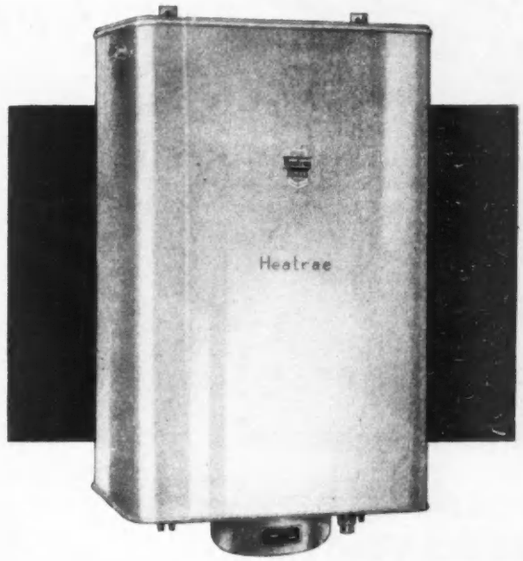

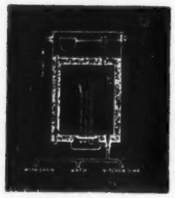

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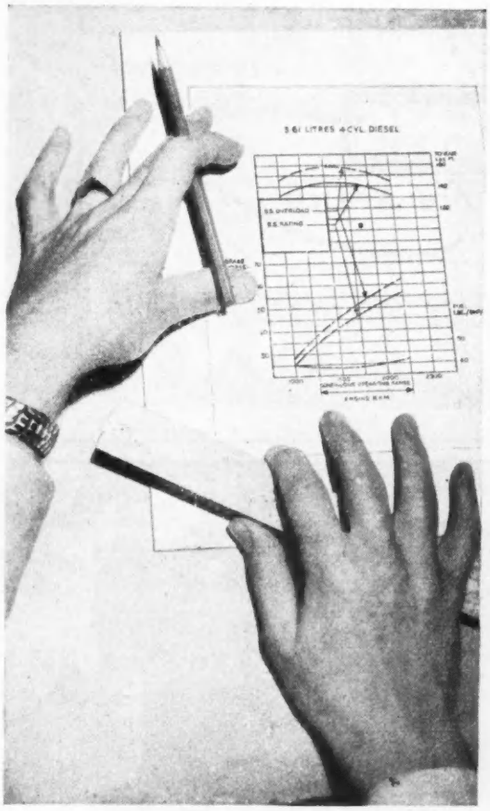
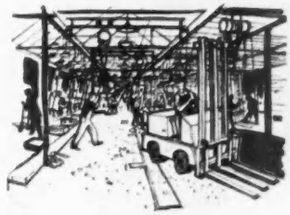


POWER for industry



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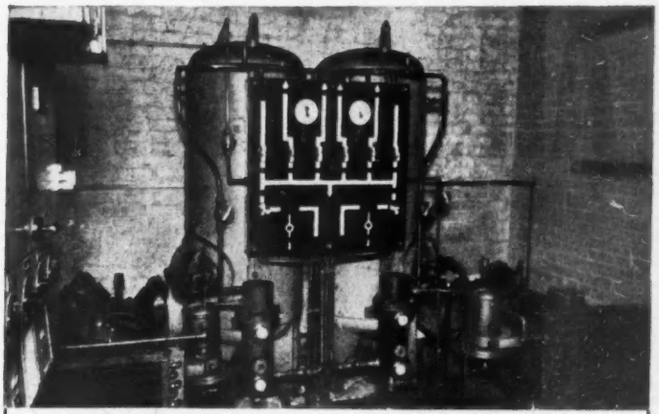
It's just plain good sense to fit Vokes filters in your air lines

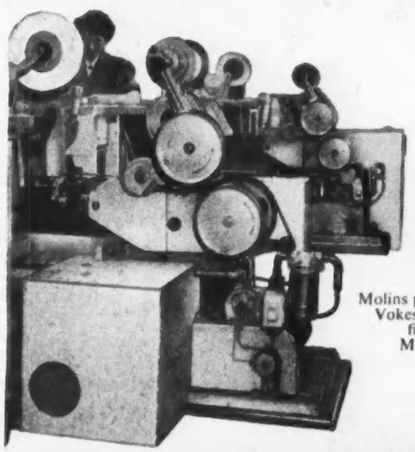


SWITCHGEAR: Vokes C.P.H. filters fitted in an air-operated switchgear room at Kingston power station.

Yes . . . it's good sense to protect air-using plant and machinery against damage, when the protection costs so little. Vokes standard pipe-line filters for instance at strategic points along the line, prevent water, scale and rust from reaching compressed air tools and causing early breakdown and loss of efficiency.

And for special applications, such as in the manufacture and processing of chemicals and food, the packing of cigarettes, there are Vokes pipe-line filters with special silver grey paper elements, excluding not only the "major menaces" but also oil mist and minute particles of foreign matter which present a hazard to the product or the process.

Fit Vokes pipe-line filters—maintain them regularly—and their installation will be repaid a hundred times over.



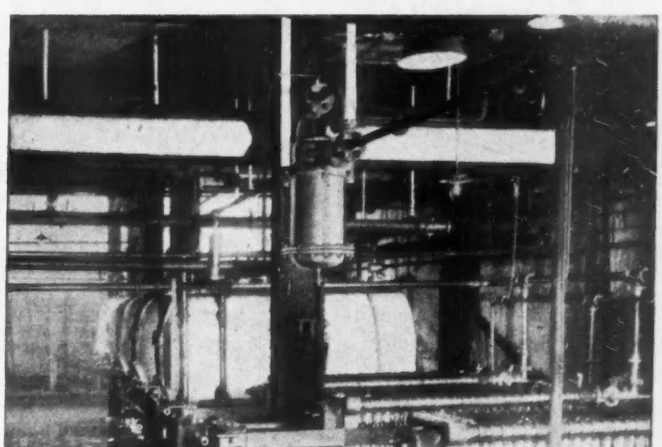
CIGARETTE PACKING

Molins packing machine, showing Vokes Compressed Air Pipeline filter (Photo by courtesy of Messrs. W. D. & H. O. Wills)

VOKES

PIPE LINE FILTERS

Give protection all along the line



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Vokes Australia Pty. Ltd., Sydney. *Represented throughout the World.*

VOKES—Air and Gas Filters for Chemical, Nuclear Energy, Oil Refinery, and Pharmaceutical applications etc; Air conditioning filters; Compressed air pipe line filters; Air, Oil and Fuel filters for Diesel, Gas Turbine, and other i/c engines; Hydraulic filters; Silencers for Engines, Fans and Blowers; High efficiency Multi Cyclones. V334

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- SUITABLE FOR HANDLING MOST INDUSTRIAL GASES
- NO CONTAMINATION FROM INTERNAL LUBRICATION
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PRICE REDUCTIONS OF UP TO 20%

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As a result of recently introduced "production line" manufacturing methods, we are able to offer the twin advantages of greatly reduced prices and immediate deliveries of Holmes-Connersville Positive Air Blowers within the following size ranges.

Capacities up to 450 c.f.m. at pressures up to 8 lb.p.s.i.
Capacities up to 700 c.f.m. at pressures up to 5 lb.p.s.i.

Holmes-Connersville Positive Air Blowers have been designed to give continuous trouble free service and are consequently of extremely sturdy construction. This, combined with minimum maintenance and low running costs, makes them eminently suitable for a wide range of applications where air is required at pressures up to 10 lbs. per square inch. They are also suitable for low and medium vacuum conditions.

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Gas Handling Division,
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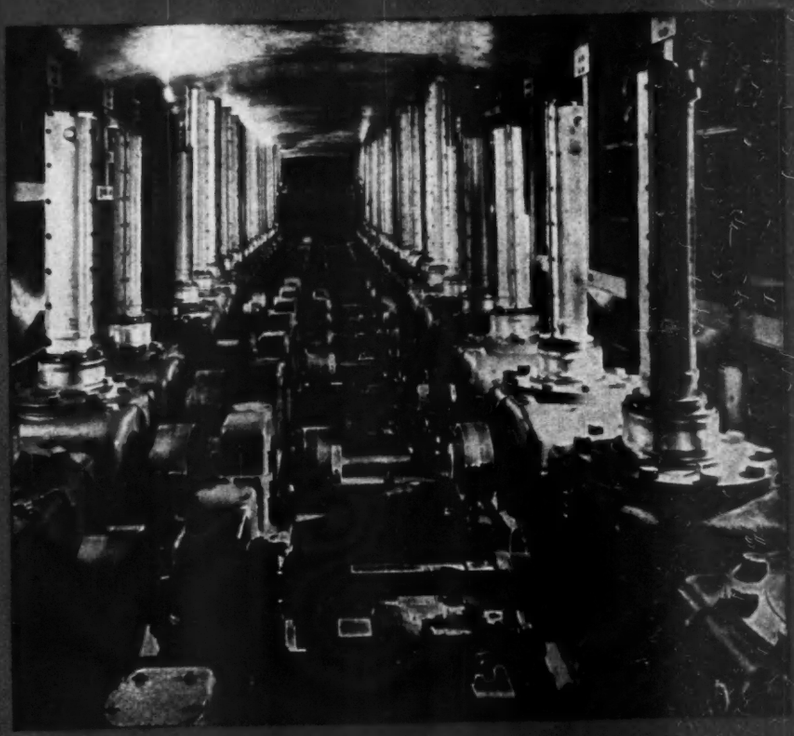
BIG JOBS

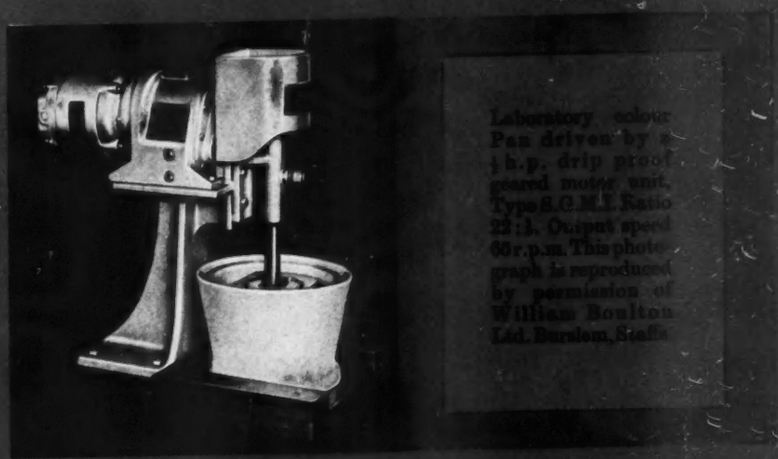
—such as supplying many special worm reduction gear units to the Royal Aeronautical Establishment for the supersonic wind tunnel at Bedford are not new to us here at Newbury, for besides non-standard units, our normal range of worm and spur units covers practically all industrial applications up to 120 h.p.



Type WGV 51 single reduction worm gearbox driven by WGV 41 single reduction gearbox. As supplied to the Royal Aeronautical establishment, Bedford, for use in the 8ft. supersonic wind tunnel. The photograph shows part of the assembly of the working section of the tunnel.

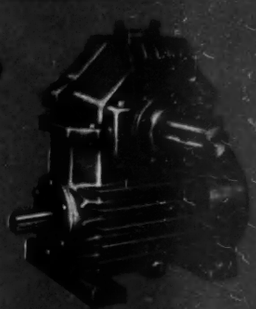
AND SMALL JOBS

—such as the production of a small gear unit for an experimental pan and muller for grinding colours is another example of our standard range. Our compact, robust helical and spur geared motors are available as double or triple reduction units in six sizes, offering a complete range of horsepowers and output speeds to the user. You can't go wrong if you specify—



Laboratory colour Pan driven by a ¼ h.p. drip proof geared motor unit. Type S.G.M.T. Ratio 22:1. Output speed 63 r.p.m. This photograph is reproduced by permission of William Boulton Ltd. Burslem, Staffs.

Type SUH horizontal shaft, fan cooled worm reduction gear. Standard sizes up to 12 in. centres; non-standard sizes up to 24 in. centres. Ratios 3:1 to 100:1.



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OPPERMAN GEARS LIMITED, NEWBURY, BERKSHIRE. Telephone: Newbury 1701 (4 lines) Telegrams: Opperman, Newbury

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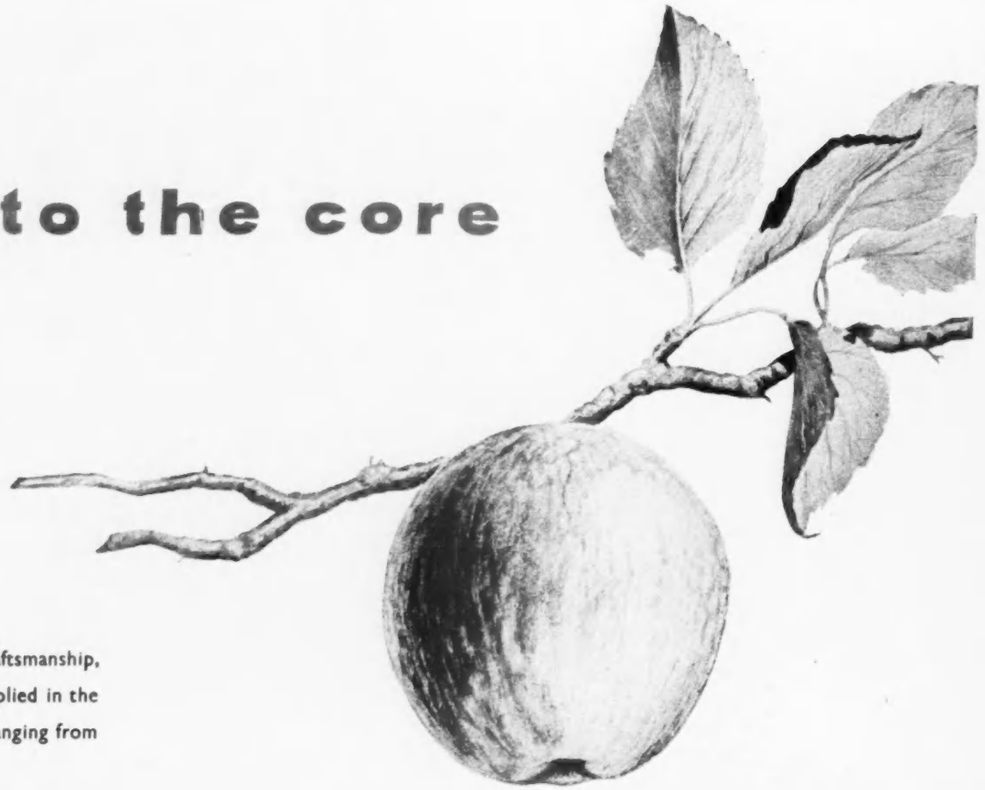
FROM A SWING BRIDGE at Tomnahurich to a Transporter Crane at Bournemouth . . . from Dock Gates at Limerick to Power Stations on the Thames--the engineering versatility, and skill and craftsmanship of ARROL of GLASGOW are amply evidenced in the design, fabrication and erection of Steel Framed Buildings, Fixed and Opening Bridges, Cranes of all types, Sliding and Floating Caissons, Pipe Lines and Surge Tanks for Hydro-Electric Projects, Mechanical Handling Equipment for modern Steel Works, and other Structural, Civil and Mechanical Engineering work. In the United Kingdom alone, even a partial list is impressive testimony of the contribution of ARROL of GLASGOW to the industrial and commercial life of the country.

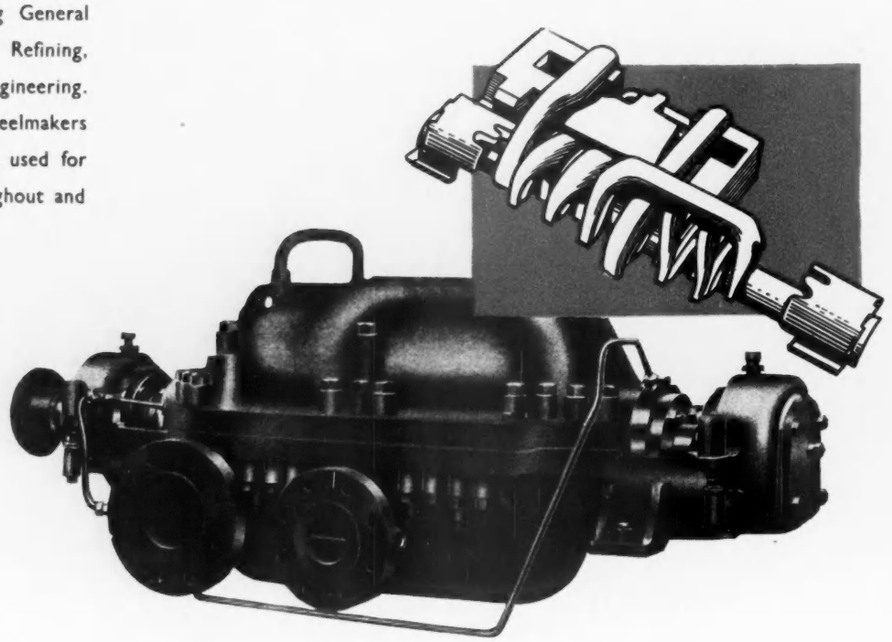
ARROL & CO LTD GLASGOW

Sound to the core



Modern steel-founding is a blend of craftsmanship, art and technology, all of which are applied in the Osborn foundries to produce castings ranging from a few pounds to several tons in weight.

Castings in carbon and alloy steels are manufactured for many industries including General Engineering, Mining, Quarrying, Oil Refining, Dredging, Chemical and Electrical Engineering. The Company's reputation as steelmakers ensures that only the finest steels are used for these castings, which are sound throughout and of the ultimate standard of quality.



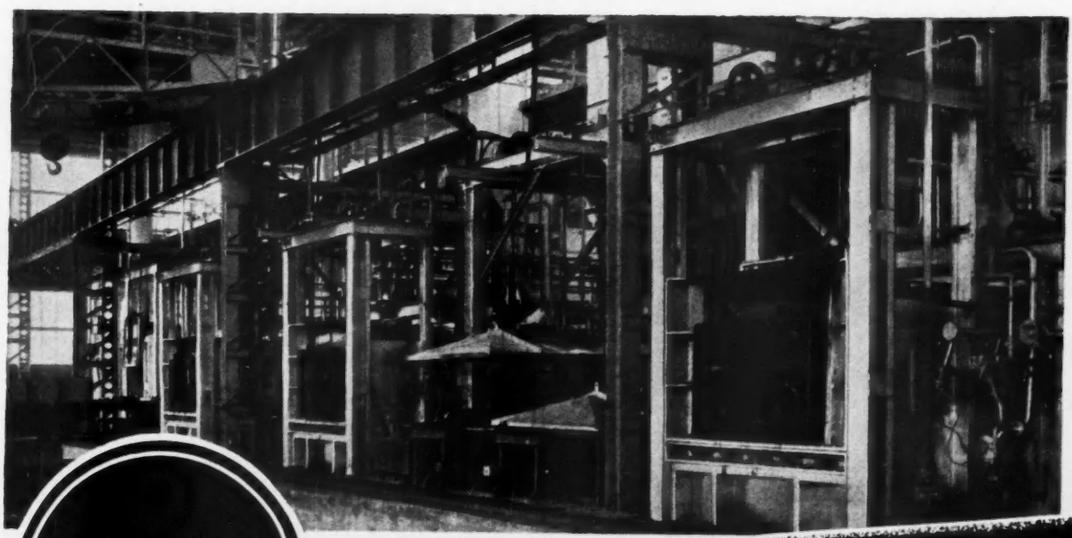
Osborn castings are used in this *Hayward Tyler - Byron Jackson six stage 'Multiplex' pump.* Inset illustrates core used for casting the upper half of casing.

OSBORN

FINE STEELMAKERS · STEELFOUNDERS · ENGINEER'S TOOLMAKERS

SAMUEL OSBORN & CO., LIMITED

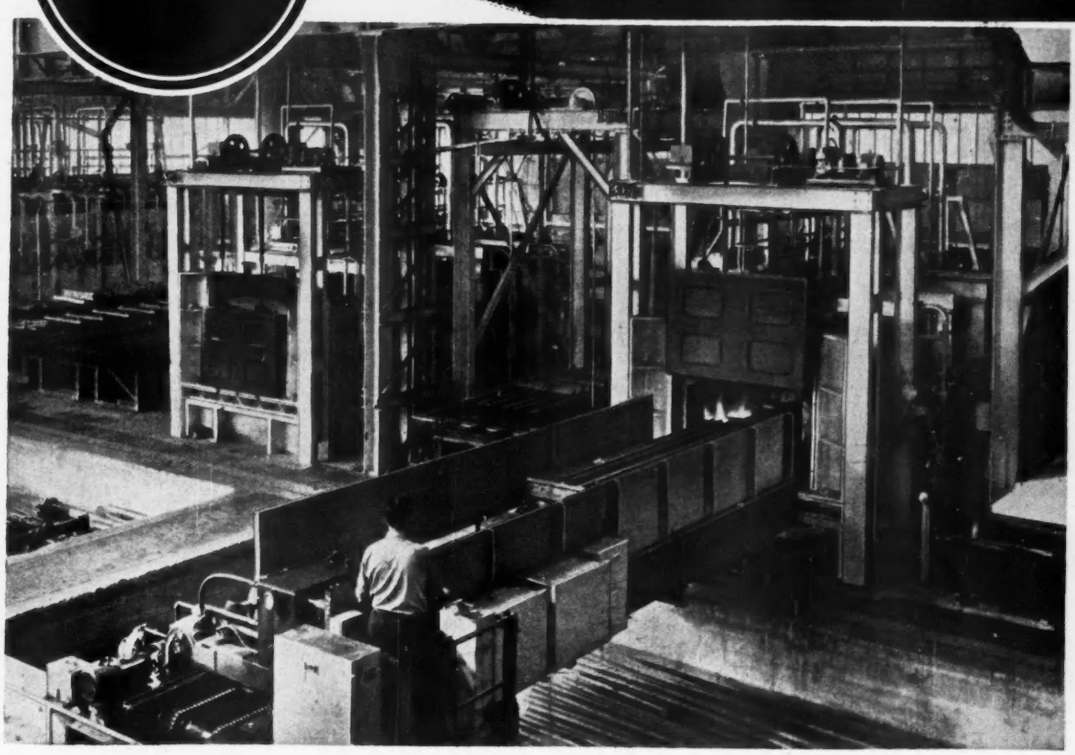
CLYDE STEEL WORKS, SHEFFIELD



FURNACES AND QUENCHING EQUIPMENT.

PRIEST

BAR TREATMENT PLANT



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We specialise in the design and construction of :—
Open Hearth Furnaces
Soaking Pits of all types
Continuous Multi-zone Bloom and Slab Re-heating Furnaces
Continuous Bogie type Ingot and Slab Heating Furnaces
Furnaces for Aluminium Melting, Coil Annealing and Slab Re-heating
Forge and Heat Treatment Furnaces
Stress Relieving Furnaces
Shipyard Plate and Bar Furnaces
Modern Lime Burning Kilns

The illustrations show a battery of 3 Heat Treatment Furnaces, one with recirculation, 5 ton 3 peel charging machine, fixed and mobile quenching equipment. This plant installed at the Stocksbridge Works of Samuel Fox & Company Limited also includes two Bogie type Furnaces with special transfer charging machine.

PRIEST

The last word in Furnace design

PRIEST FURNACES LIMITED · LONGLANDS · MIDDLESBROUGH
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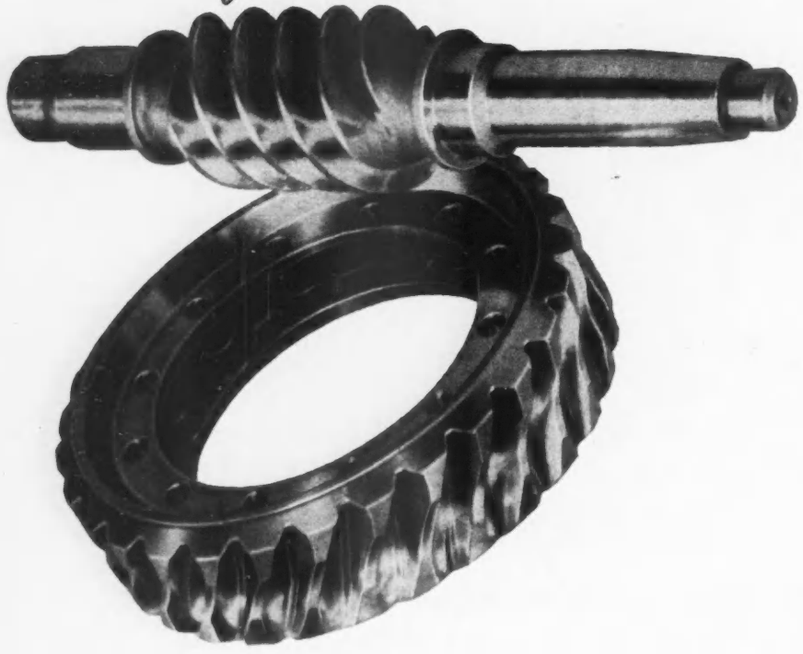
For a wonderfully smooth drive...

Holroyd worm gears



Three things are needed for making a good worm gear. First, a wheel material to give hard wear and low friction—in our case this means Holfos centrifugally cast bronze. Second, high precision machine tools, cutters and testing appliances—we have been making our own for years. Third, a thorough knowledge of worm gear design and application, coupled with an inexhaustible supply of patience—well, we've been in the worm gear business for nearly a century and during that time we've overcome some pretty tough problems. That's why we say: there is (or very soon can be) a Holroyd worm gear for almost every application.

Did you know that all Holroyd worm gears are made using a unique technique which gives some allowance for the inevitable deflection of bearings and gear housing? This gives improved performance with the gears working correctly in the **loaded** position.

In certain cases we go further than this and make the gears so that they have some latitude in assembly without impairing the efficiency.

Another point—our worm gears are made, if required, right down to 1/1 ratio as an everyday product. And don't forget that these Holroyd gears will carry several times the load of straight faced spiral gears of the same dimensions, and will work with an efficiency of the order of 97 per cent.

Have a word with **Holroyd**

90 YEARS OF GEARS

JOHN HOLROYD & CO LTD · MILNROW · LANCASHIRE

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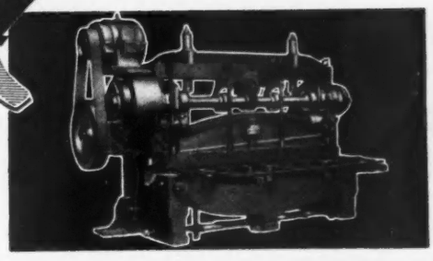

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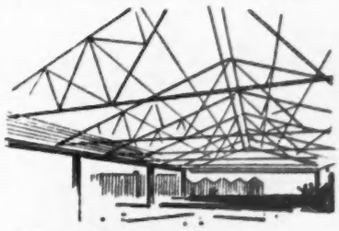

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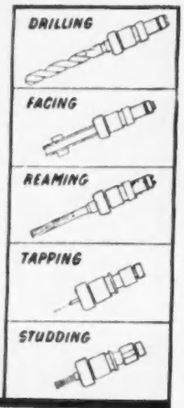

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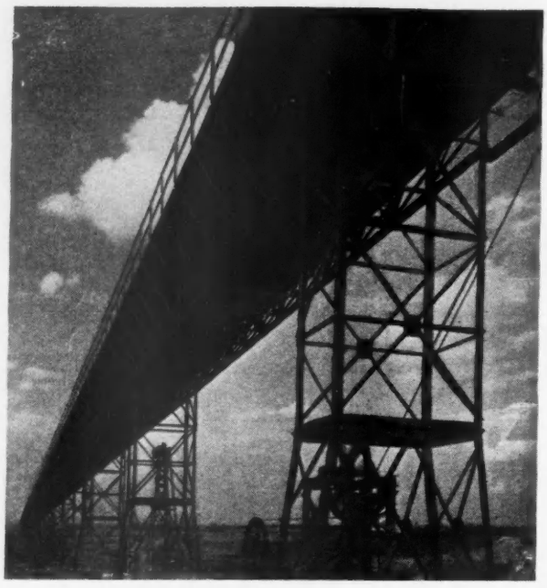

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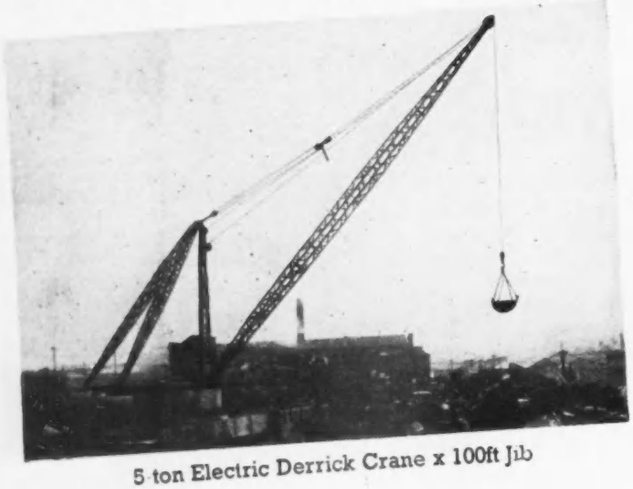

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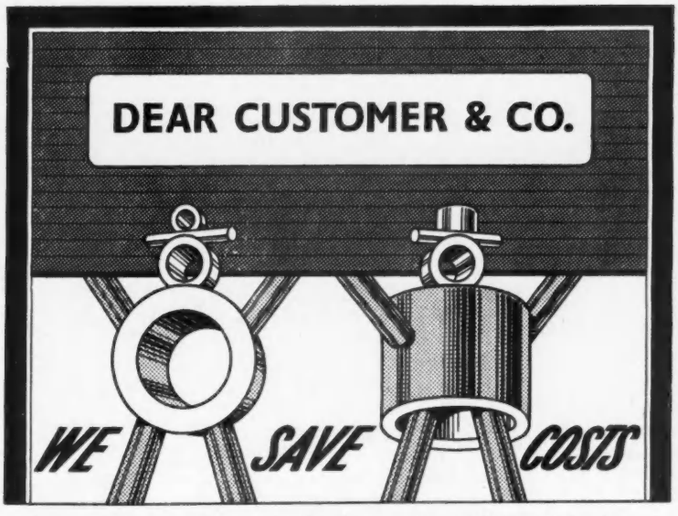

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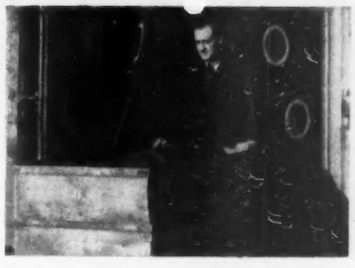

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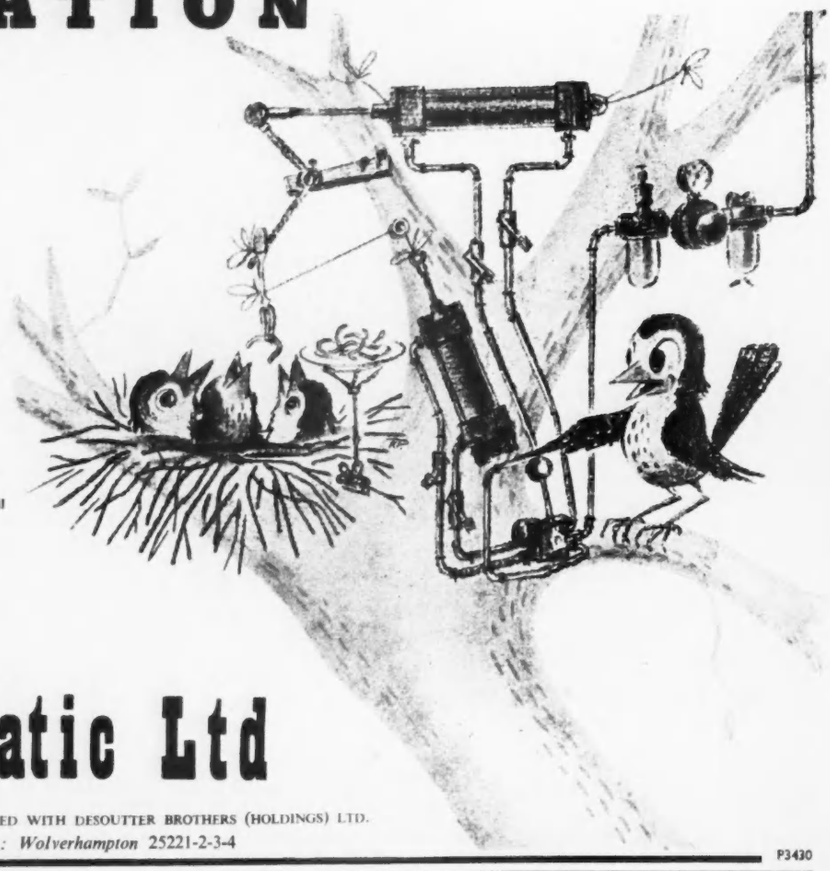

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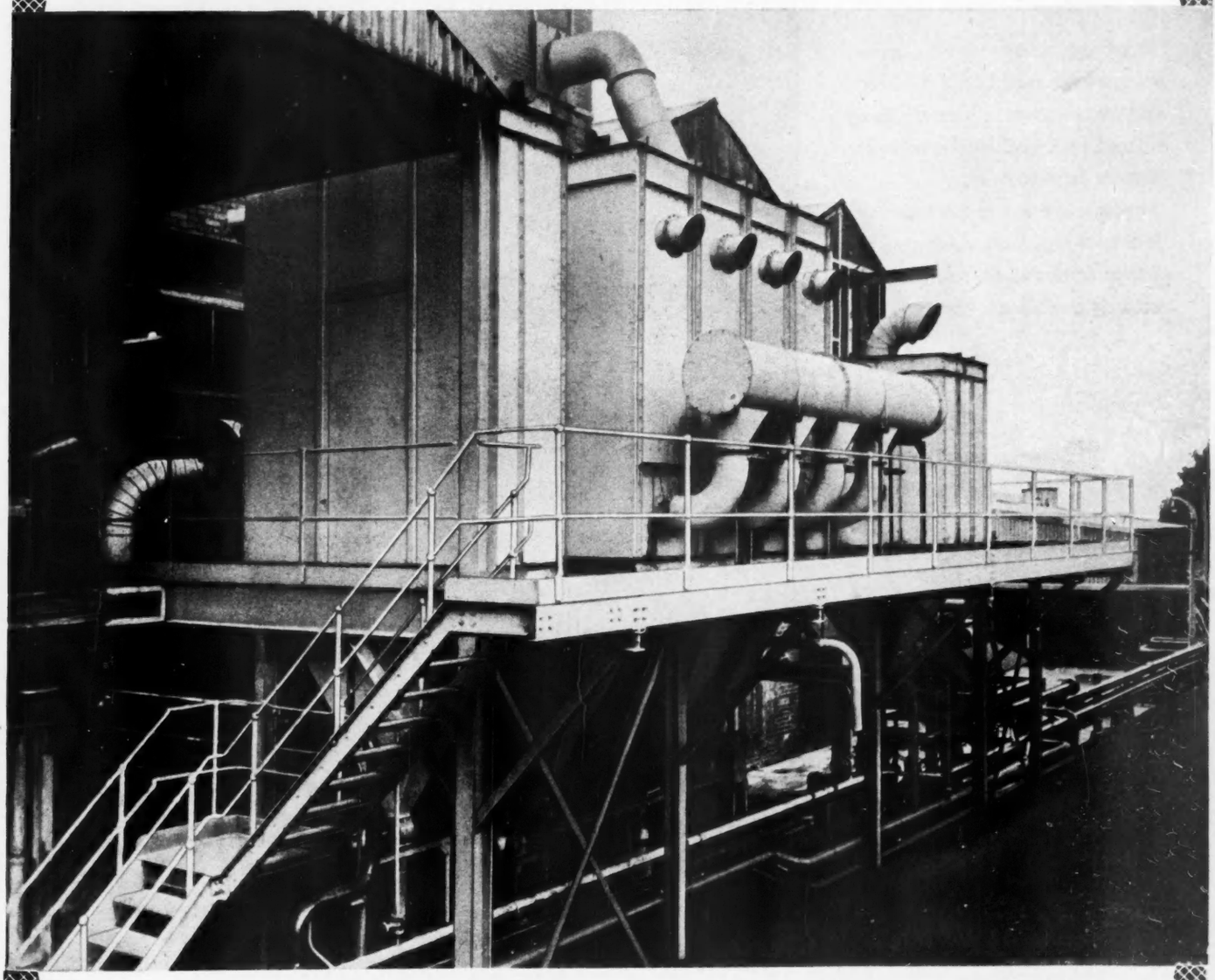

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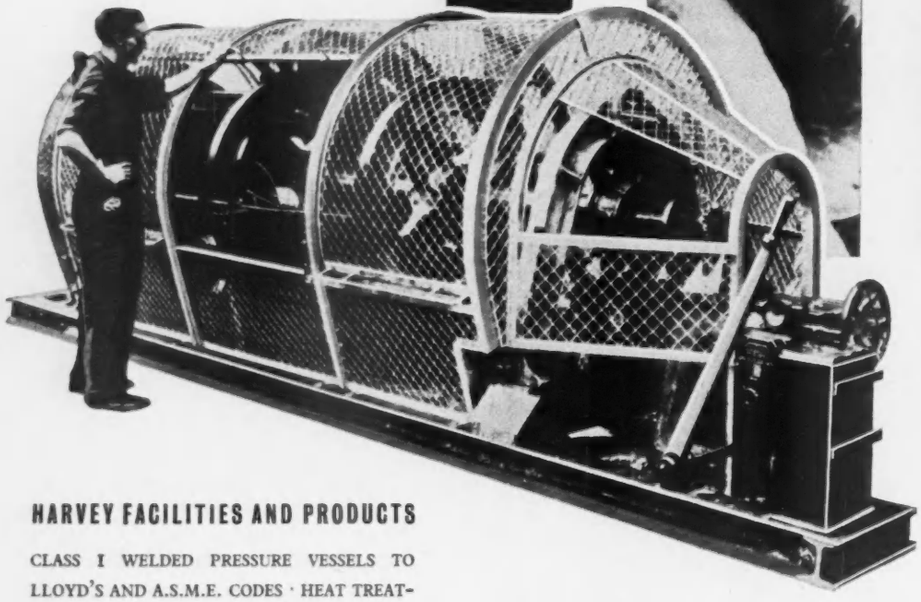

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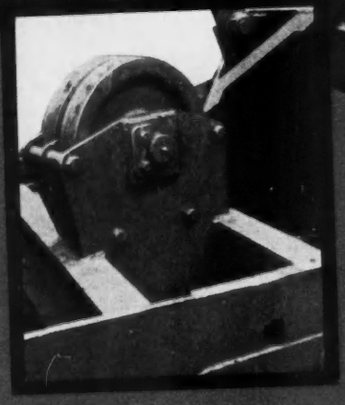

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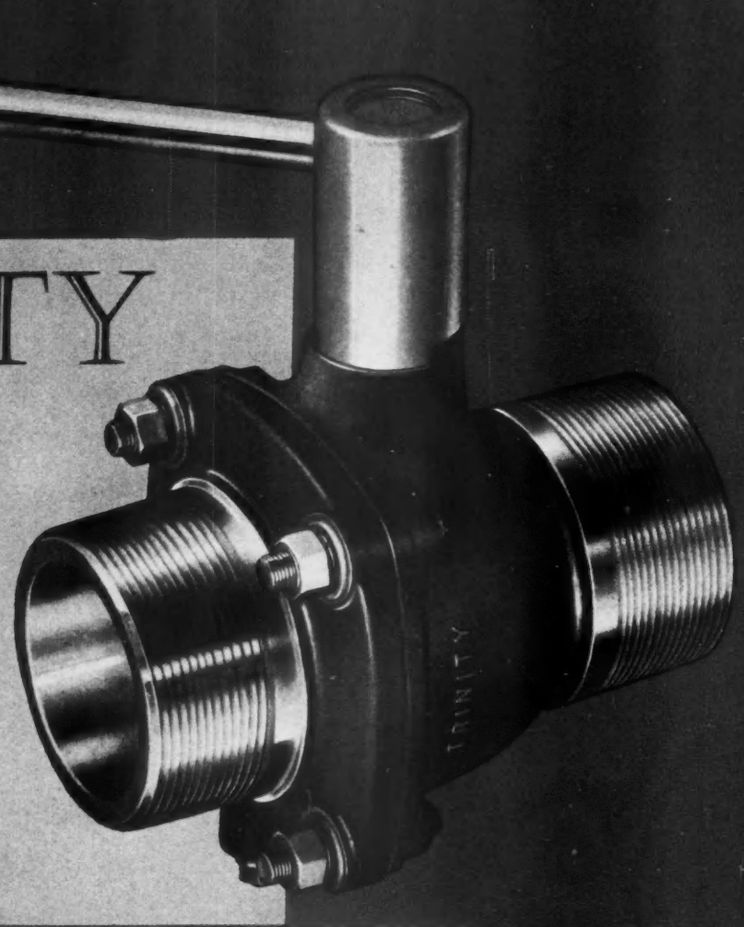

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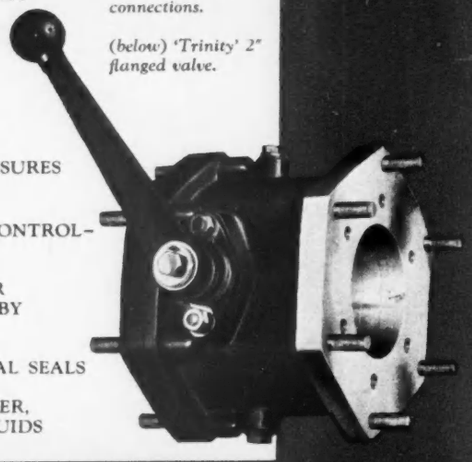
(above) 'Trinity' 2" valve for screwed connections.

(below) 'Trinity' 2" flanged valve.



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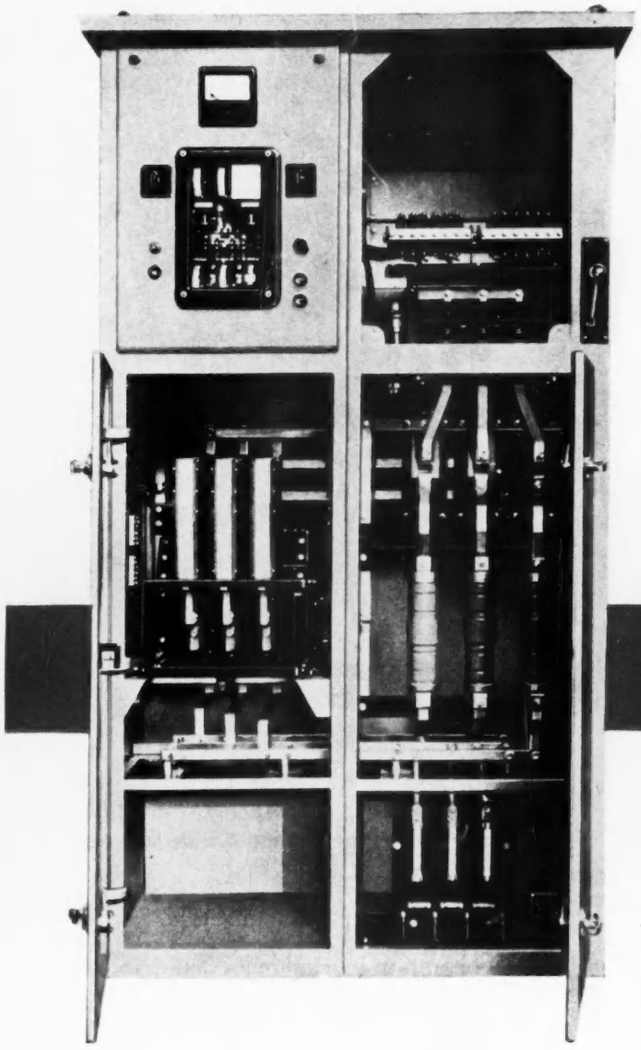

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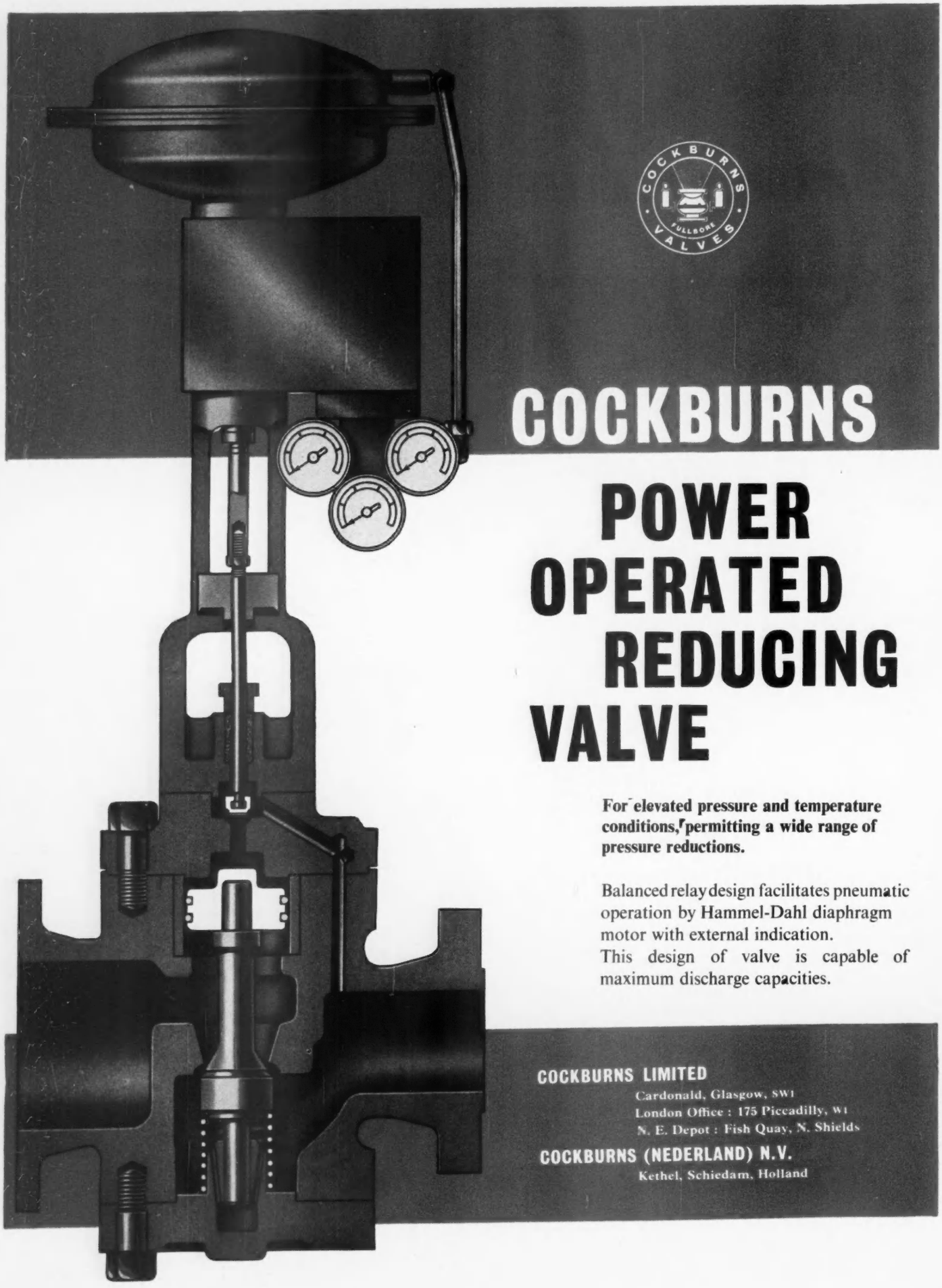

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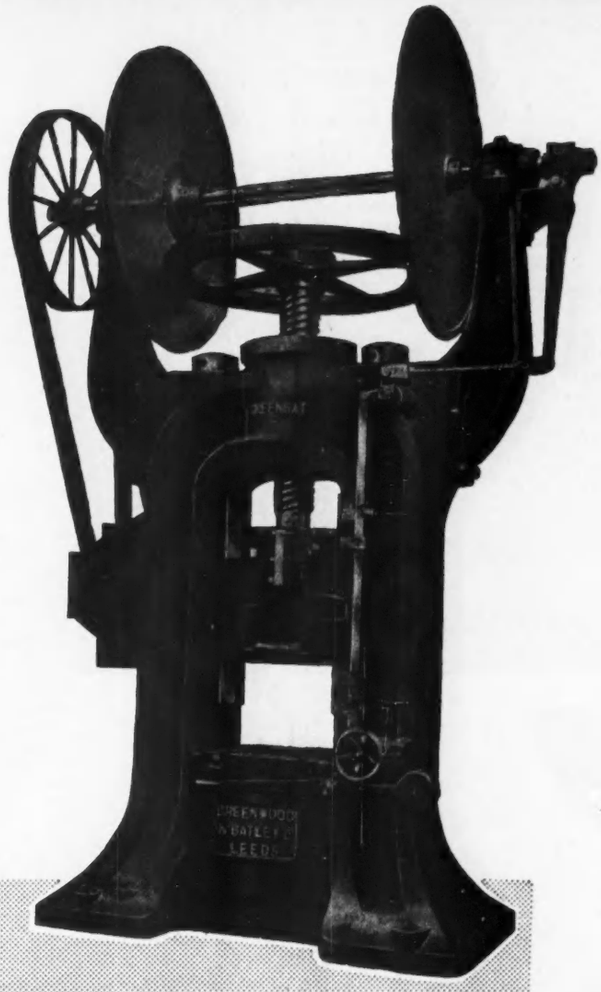

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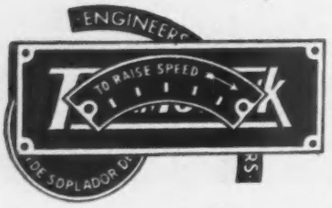

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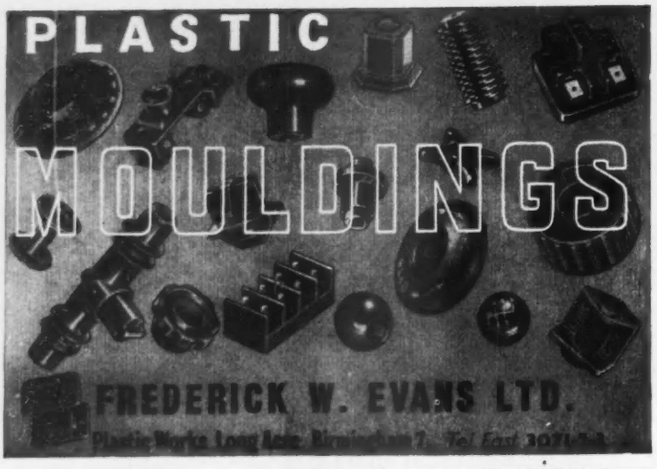

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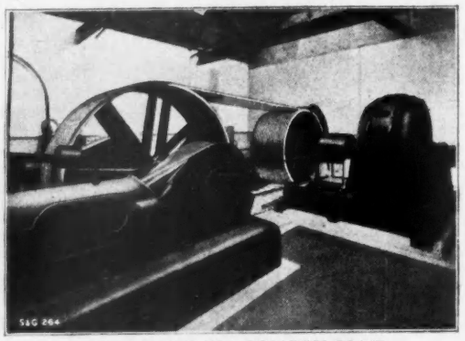

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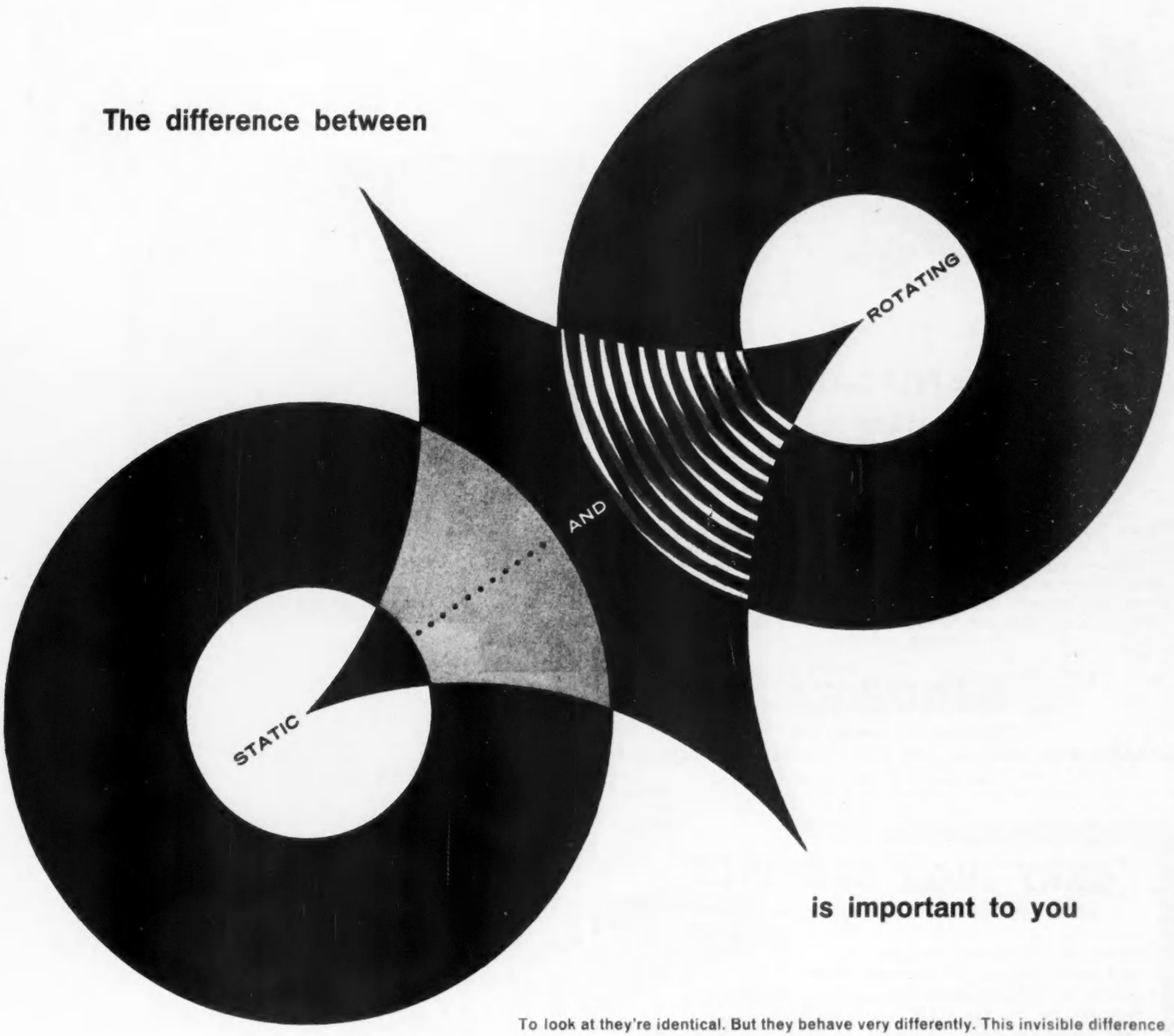

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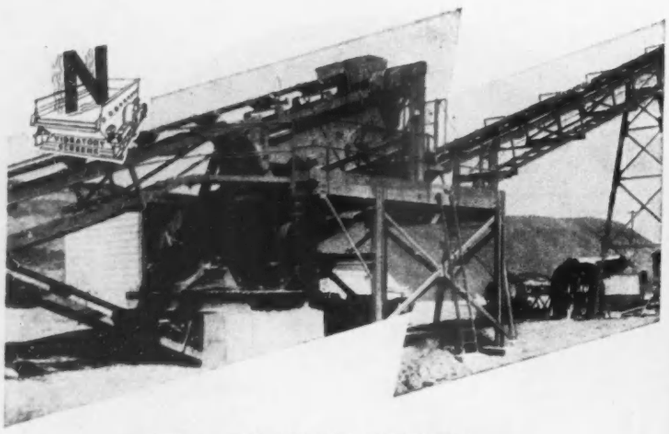

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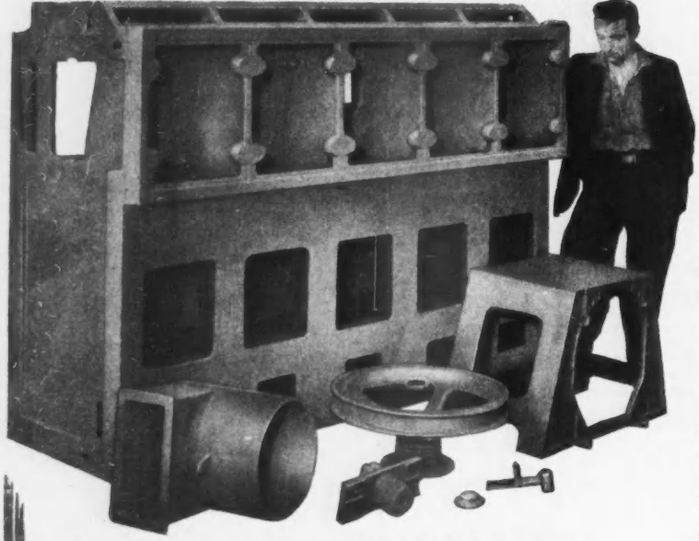

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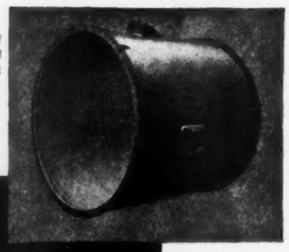
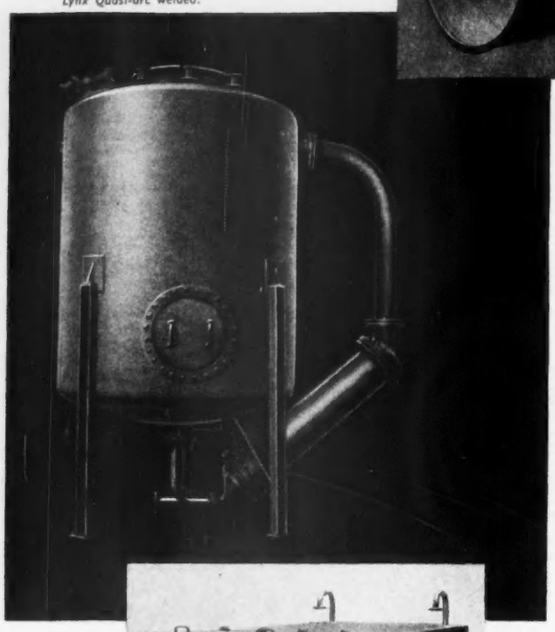


1,000 gall. kettle in ¼" copper. Lynx Quasi-arc welded.



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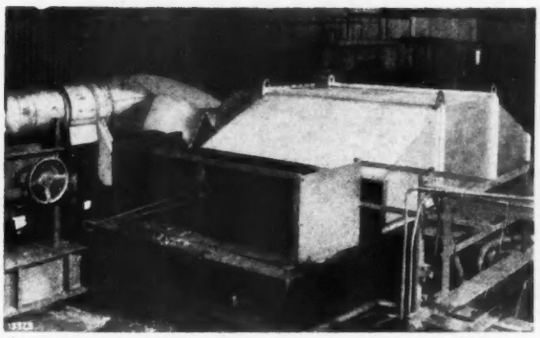

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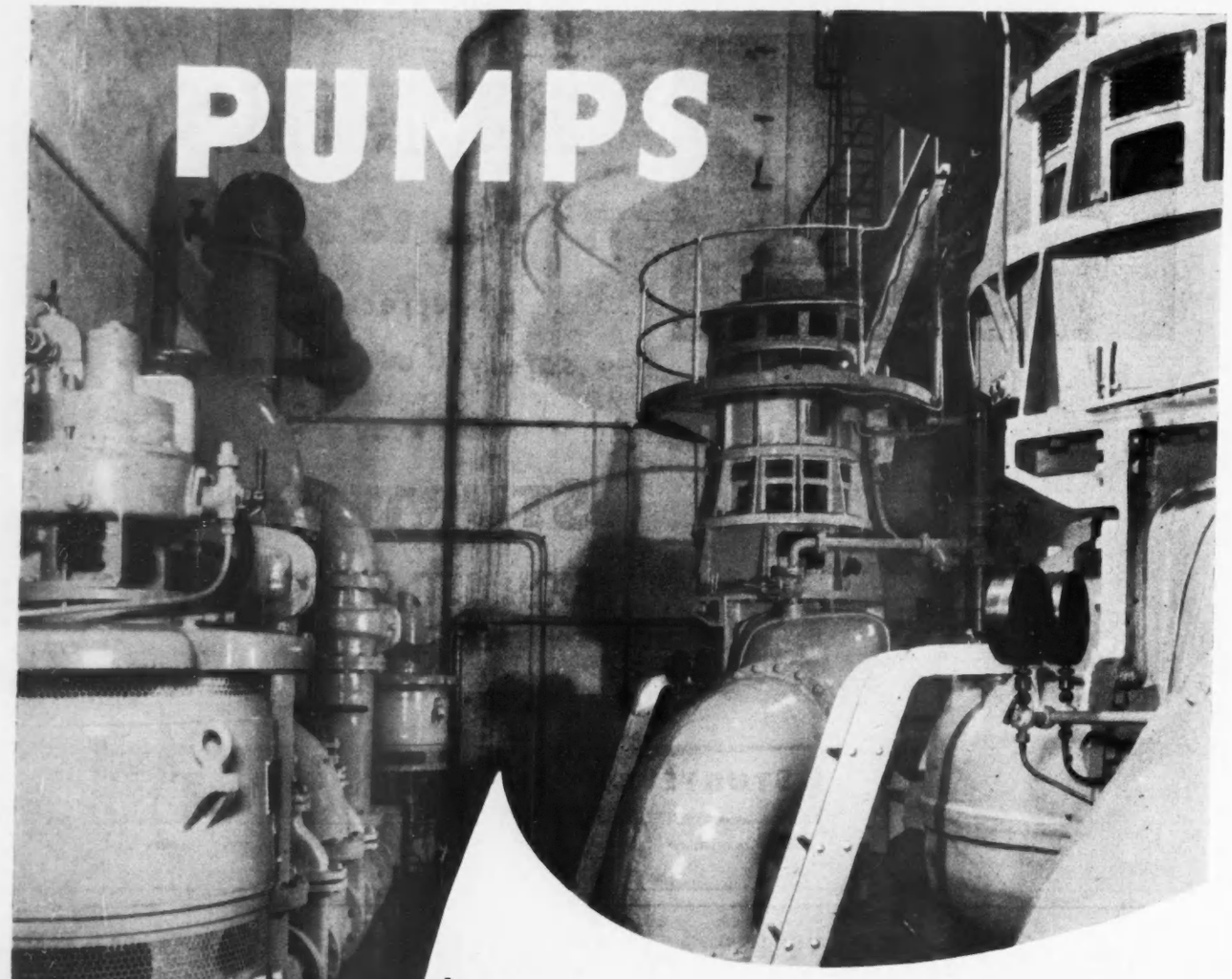

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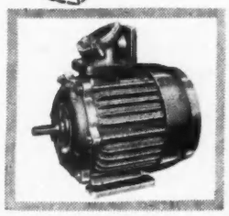

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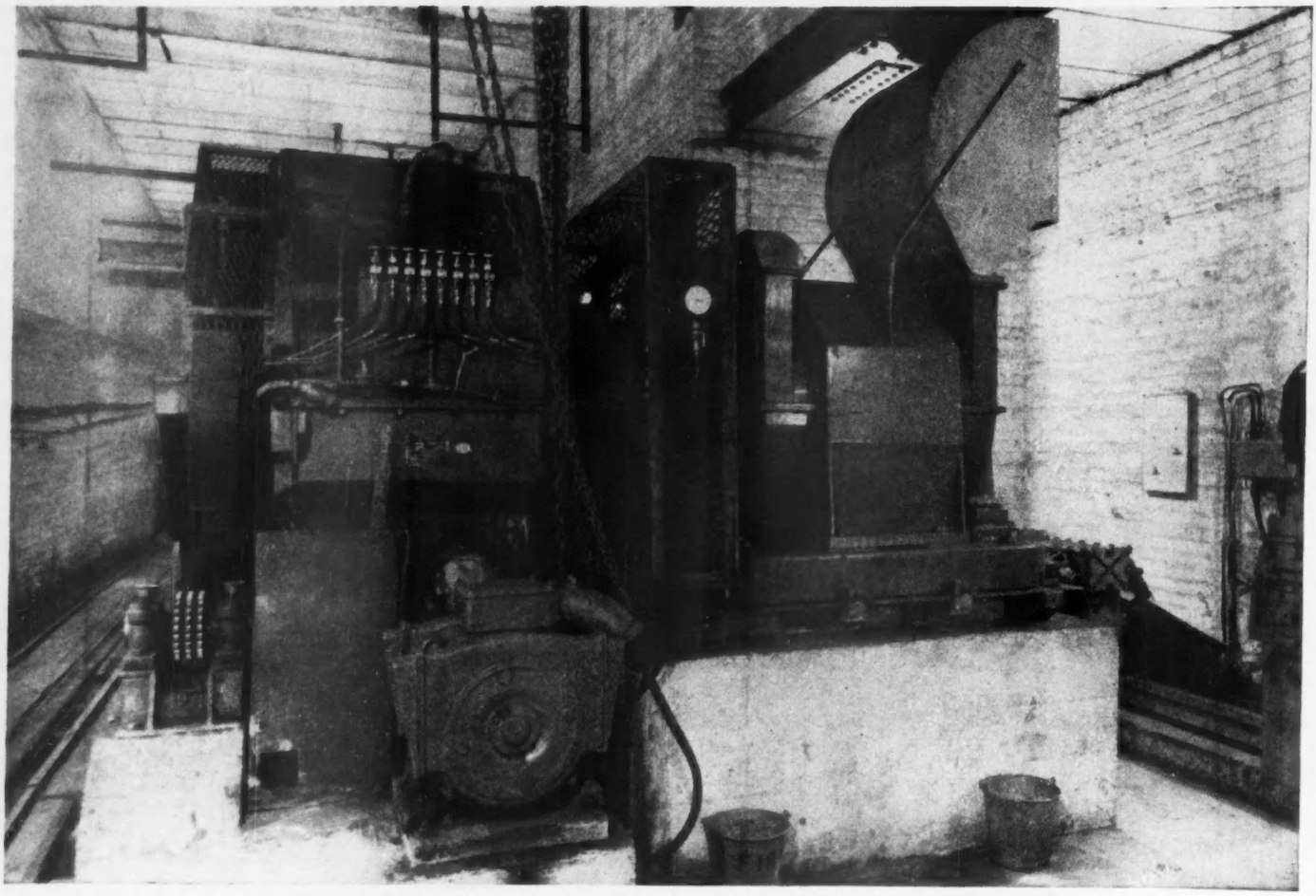

A 330 b.h.p., 3,300 v., 730 r.p.m. Mather and Platt drip proof, double squirrel cage induction motor, with air filter, driving a cable belt conveyor in a coal mine in Scotland. The motor is of the low starting current type arranged for switching direct on the line, taking 3·65 times full load current, and is directly connected to the gearing which drives the cable belt. The small motor in the foreground is for driving at slow speed for rope inspection purposes.

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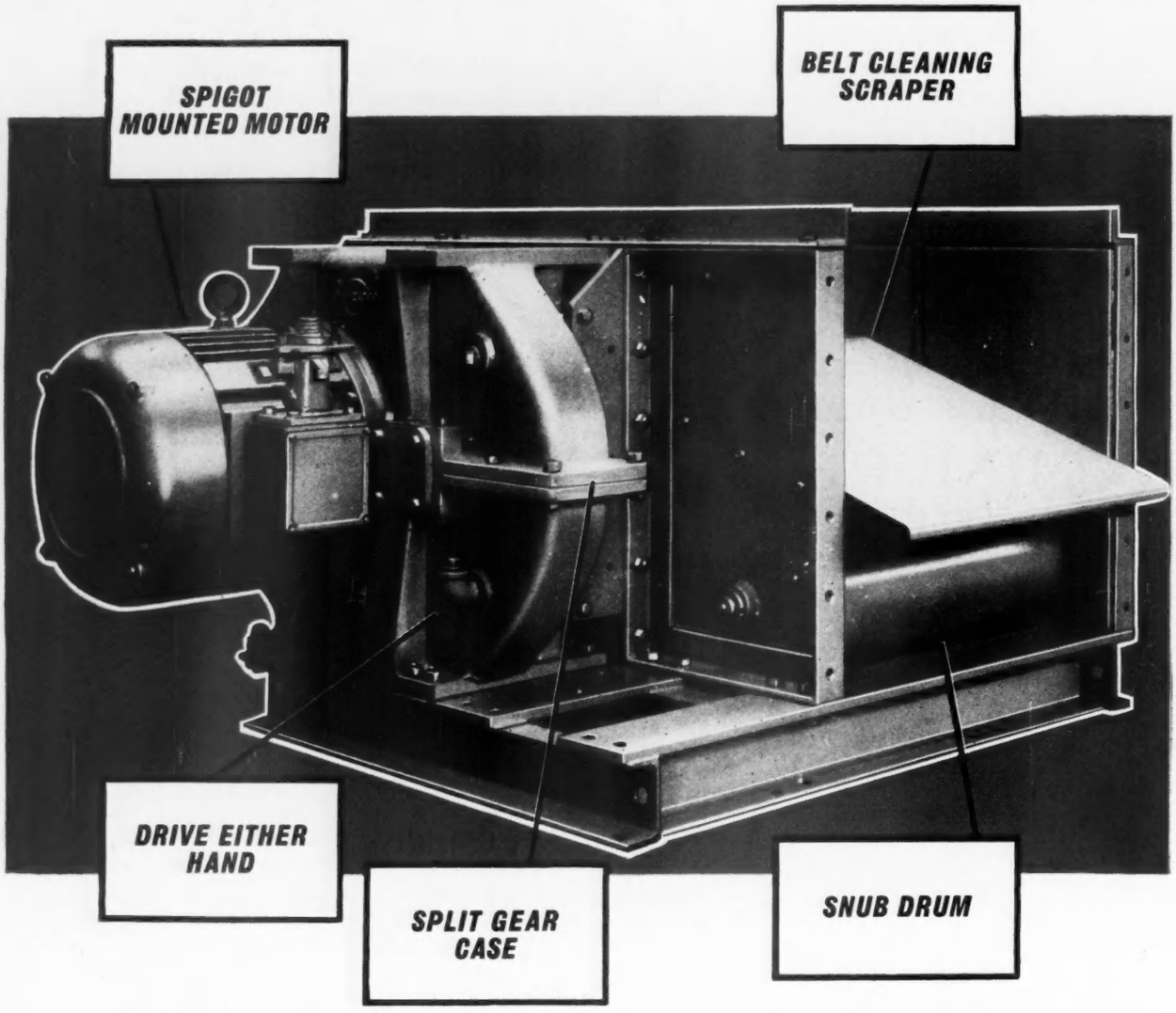

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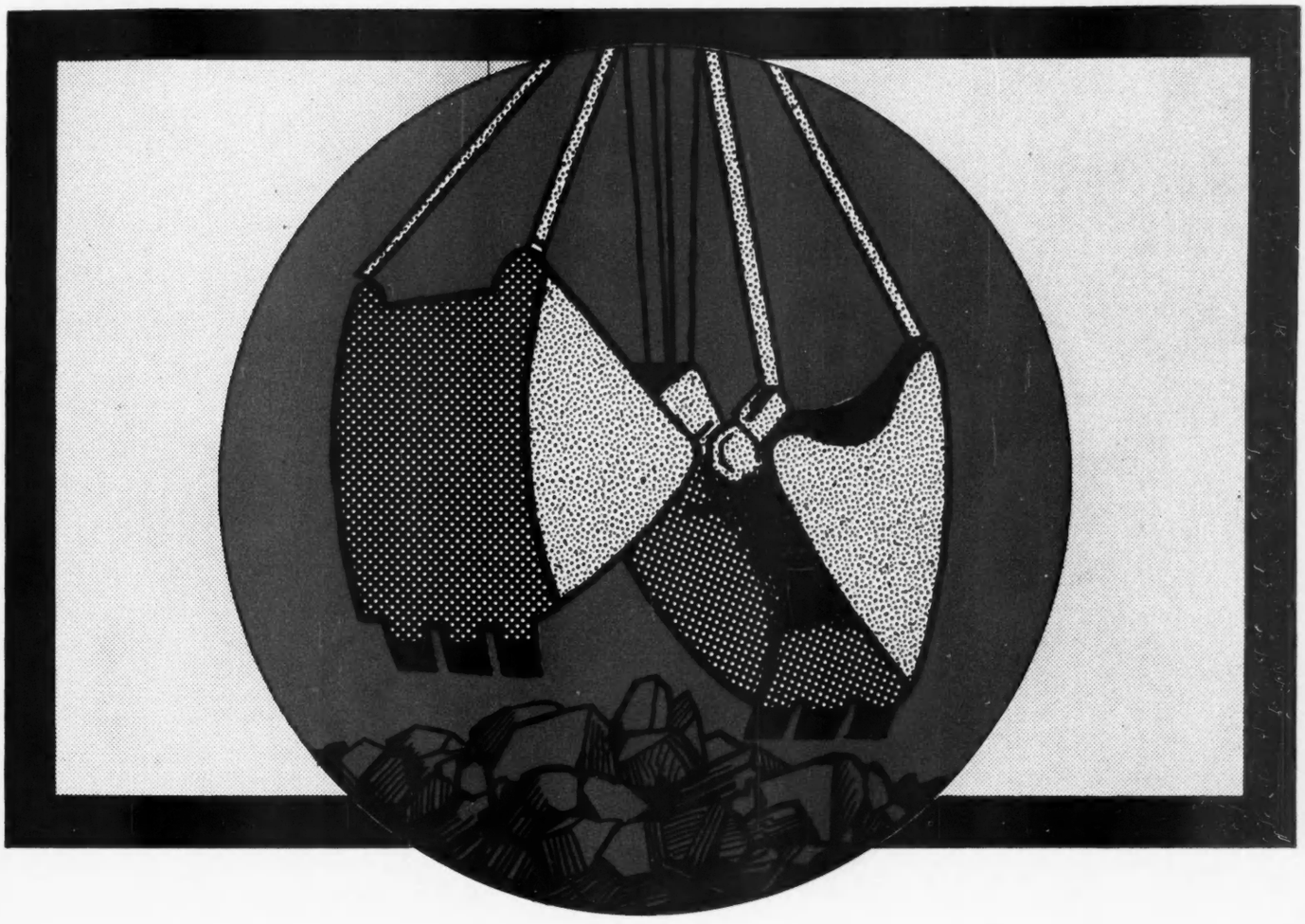

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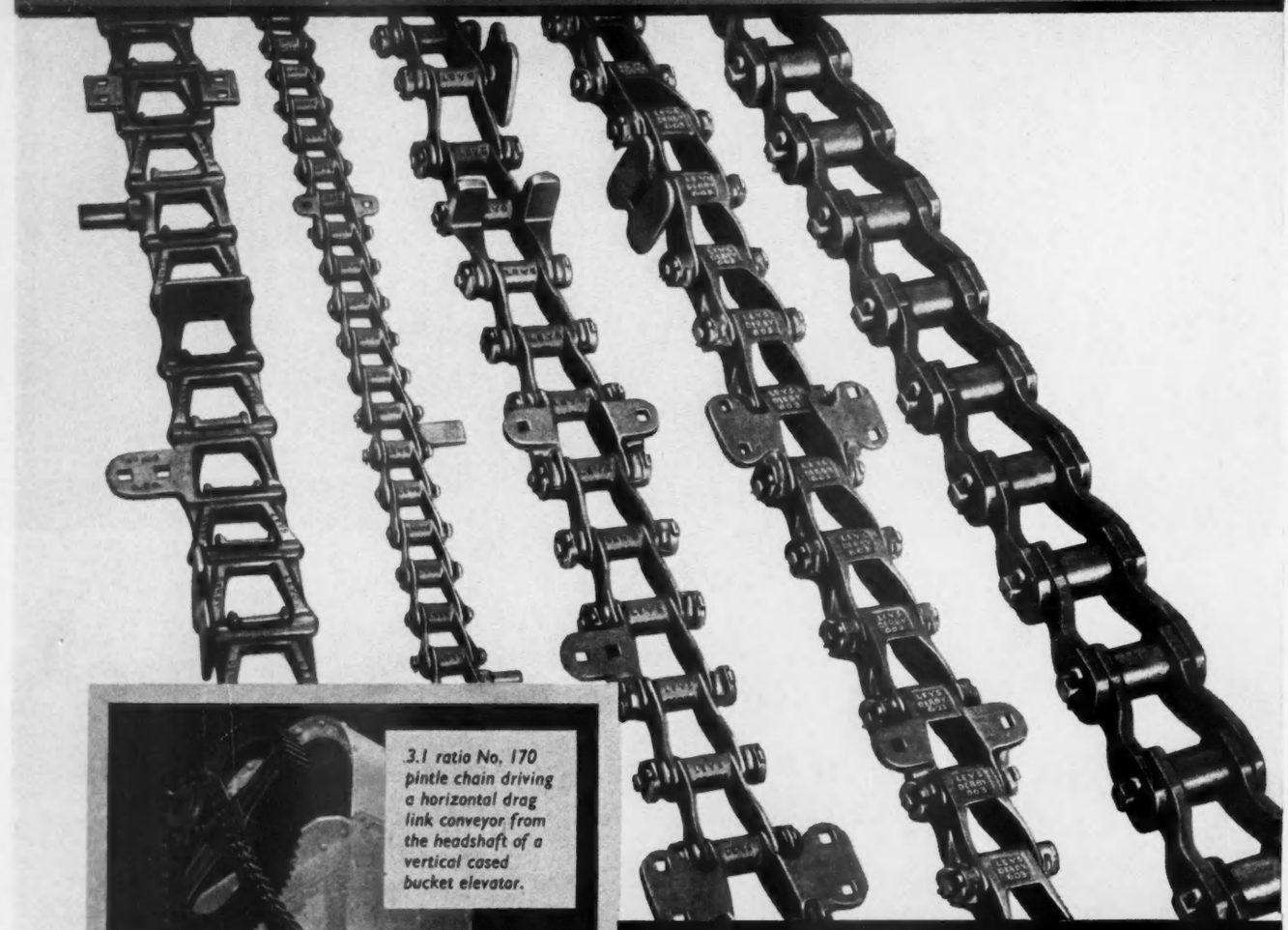

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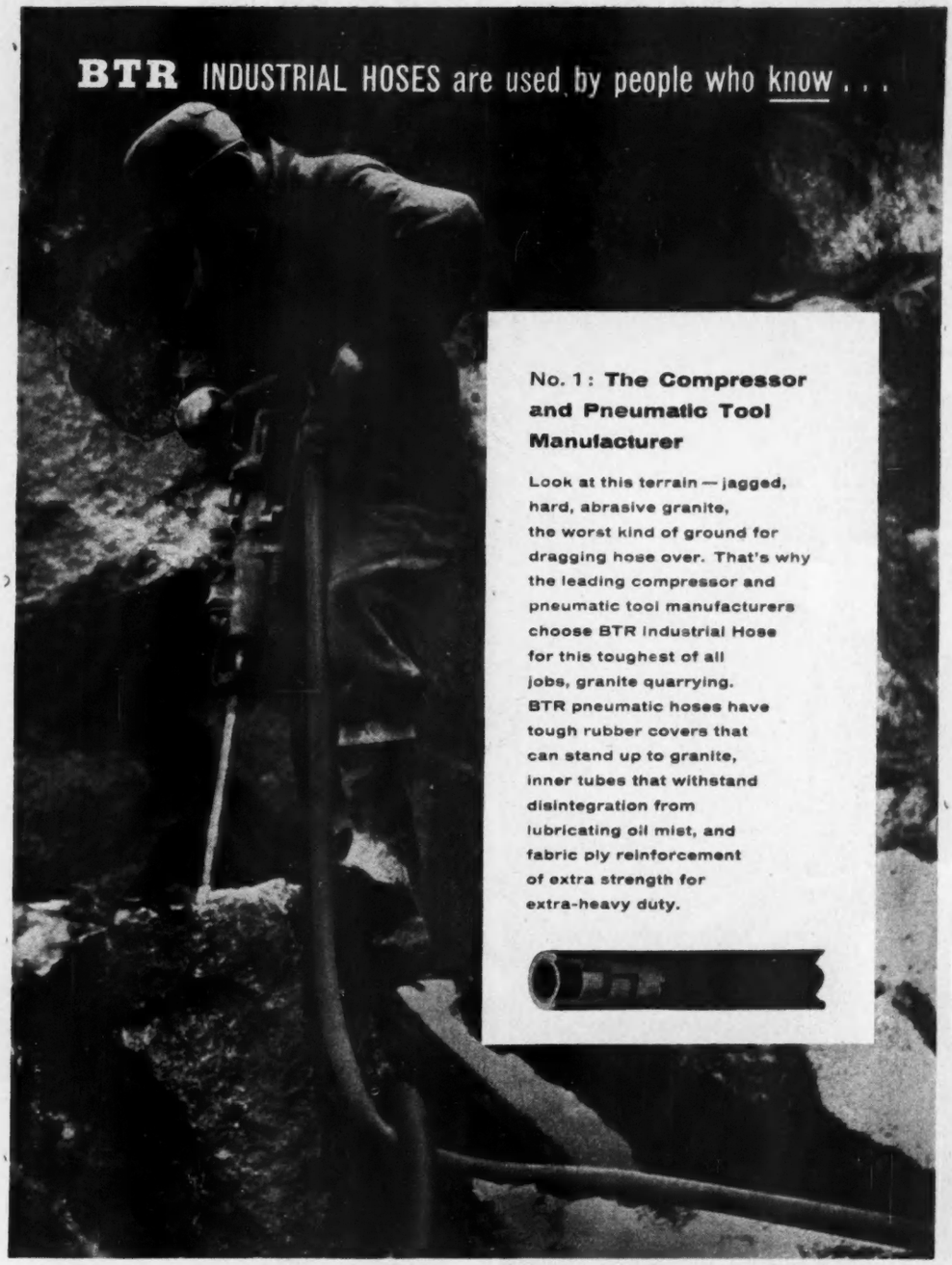
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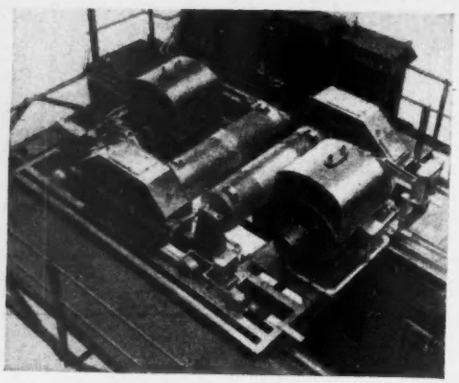

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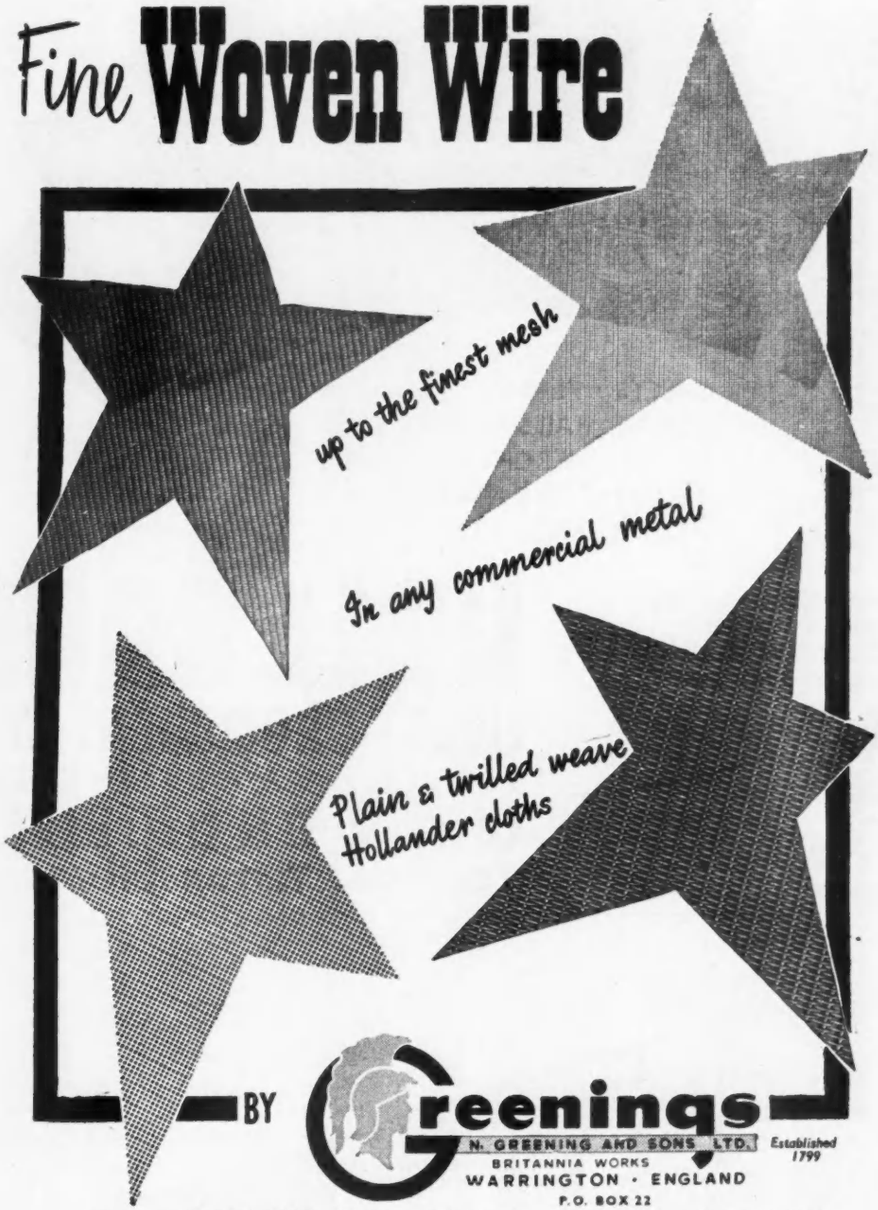

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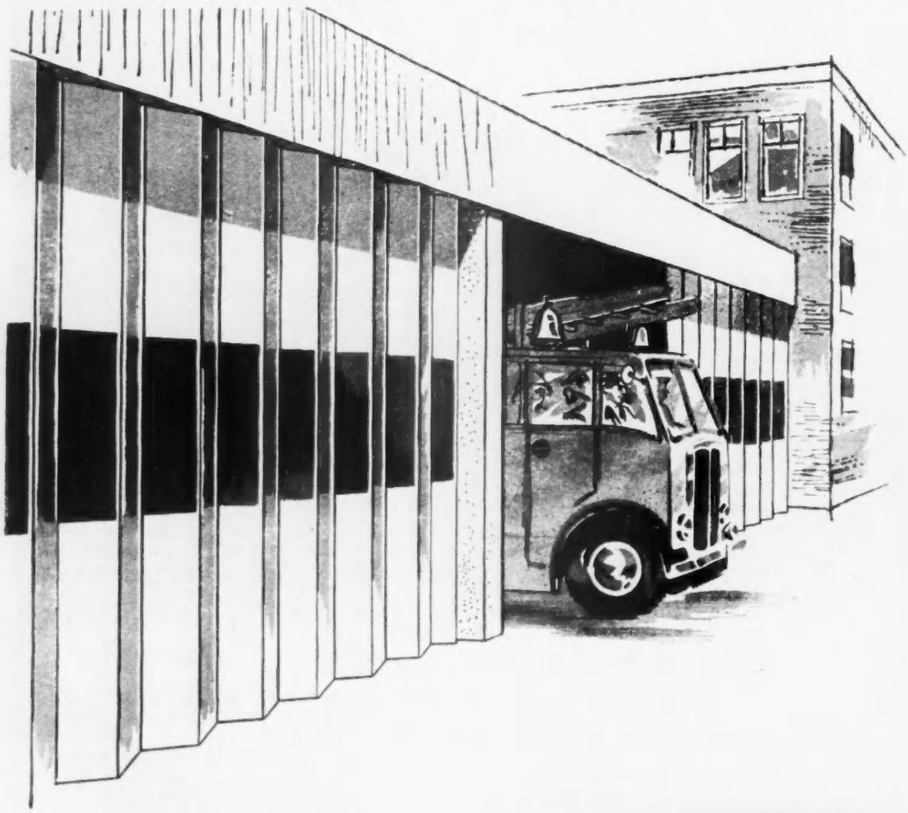

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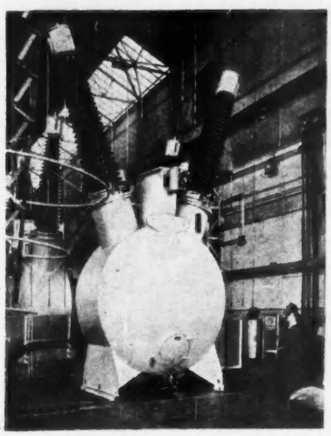

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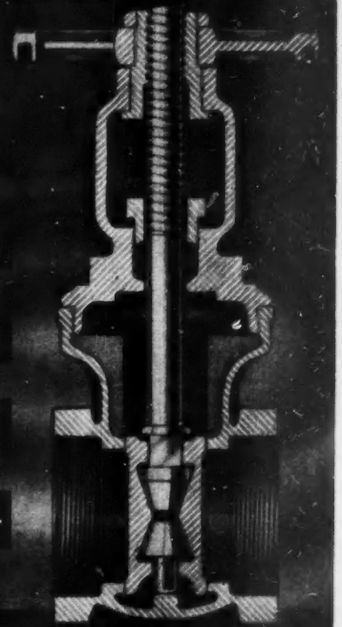

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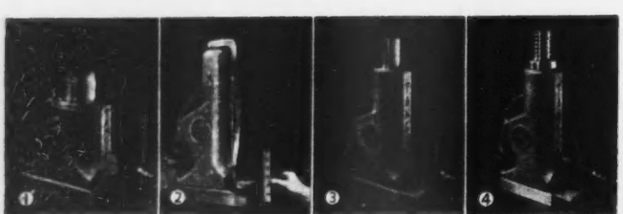
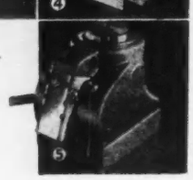


(1) A 6 ins./50 ton with plain ram. (2) Claw attach. on 12 ins./25 ton.
(3) A 12 ins./25 ton with plain ram. (4) A 12 ins./25 ton with screwed ram.
(5) A 6 ins./100 ton jack.



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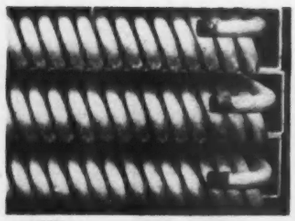

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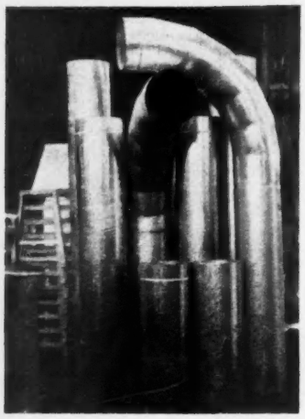

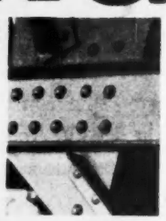

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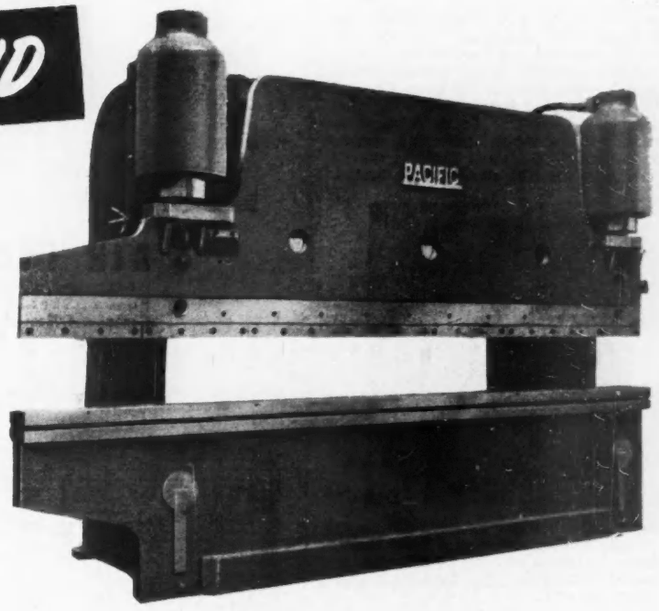

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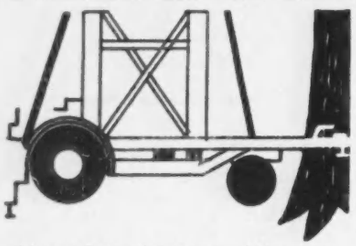

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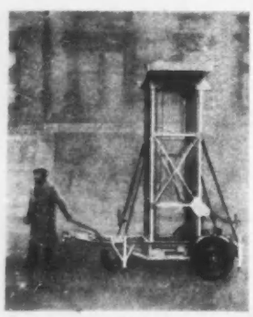

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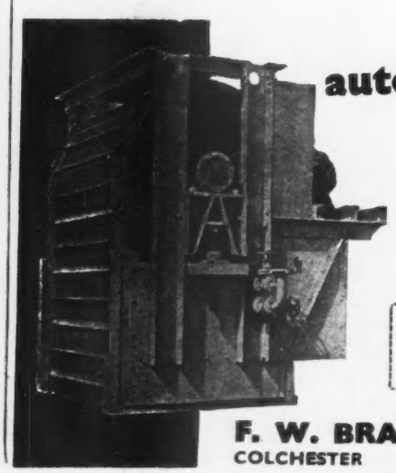

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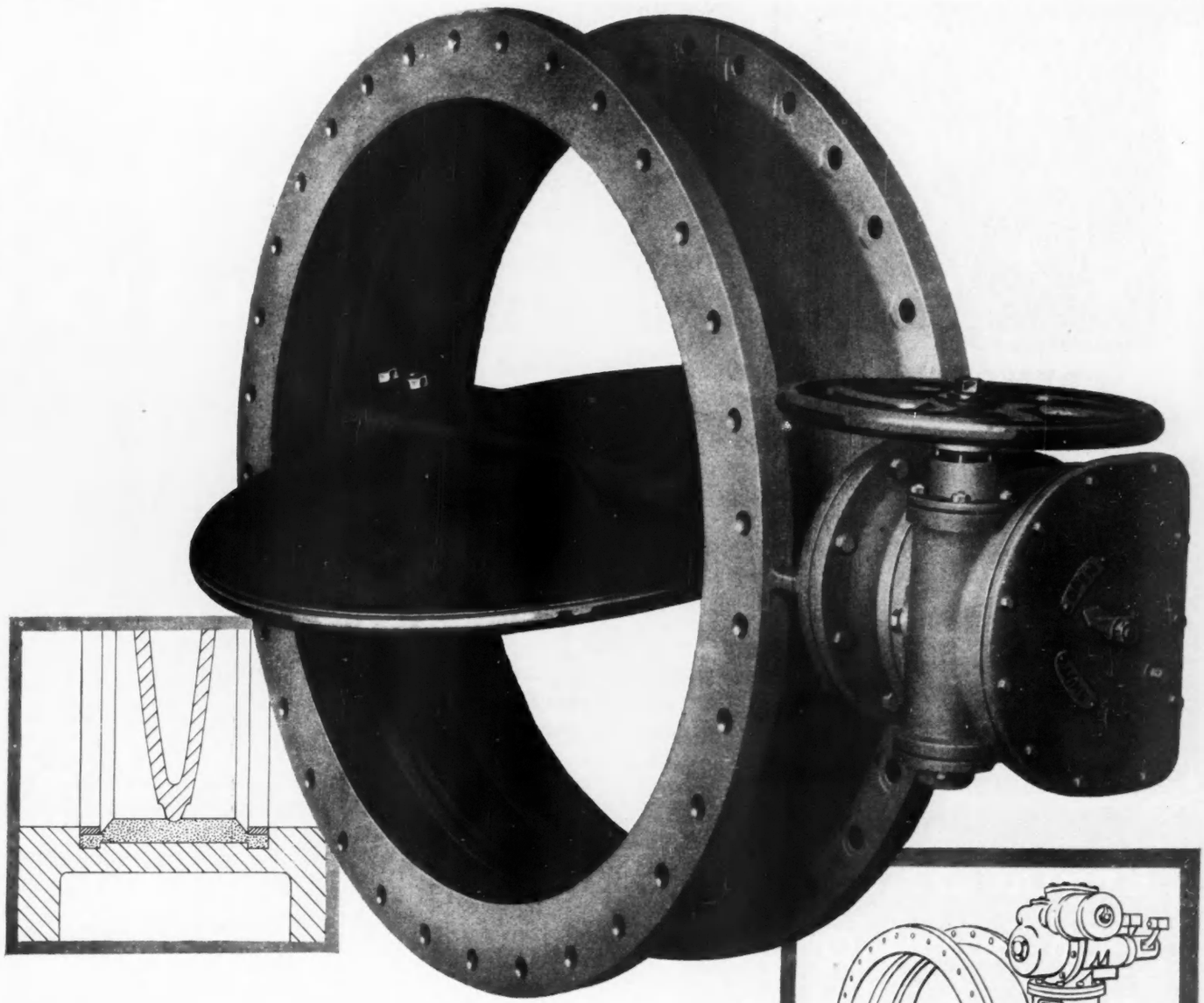

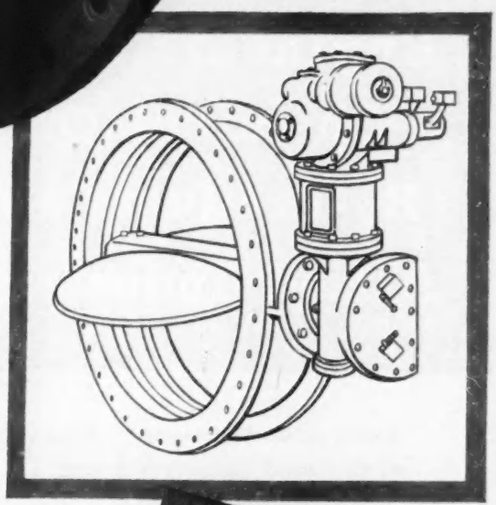

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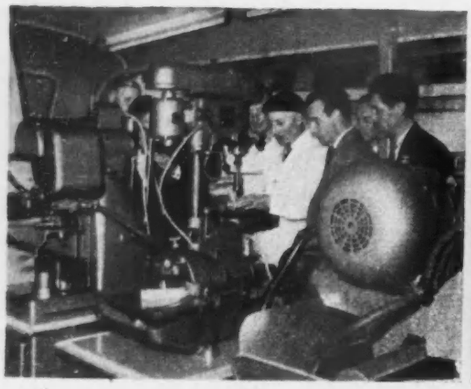

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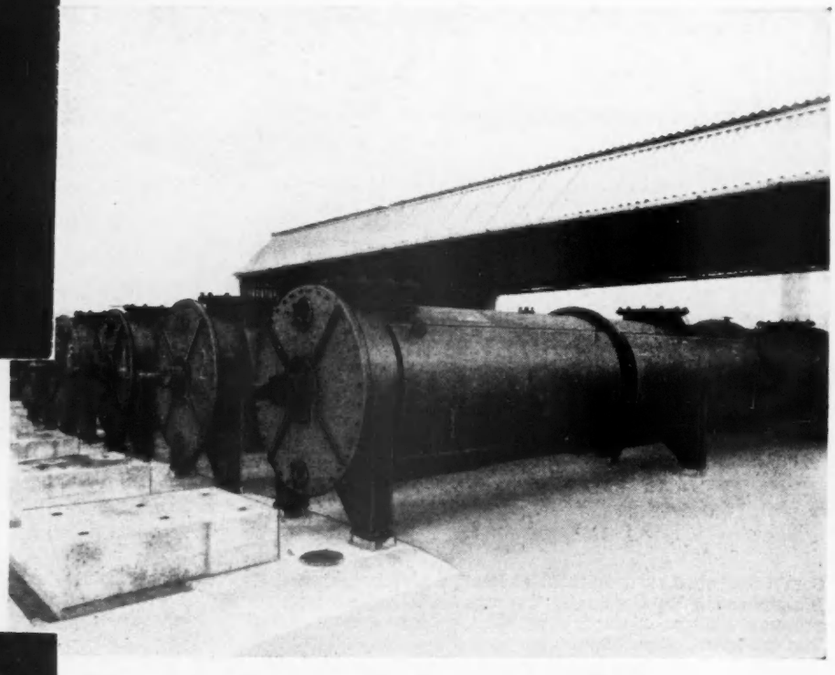

Battery of 10—Naphthalene Crystallisers. Shells jacketed. Each unit 30′ 0″ long. Location flat concrete roof at 80′ 0″ level. Illustration by courtesy of Yorkshire Tar Distillers Ltd., Cleckheaton, Yorkshire.

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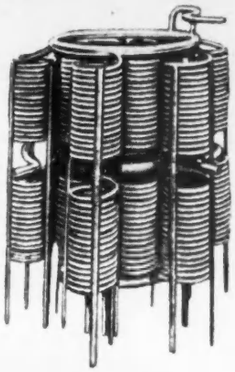

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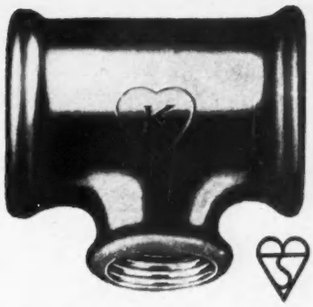

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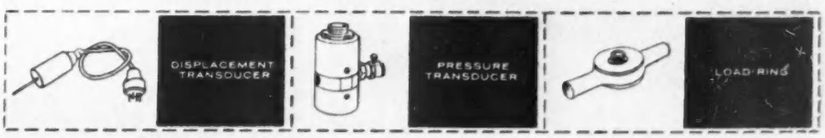

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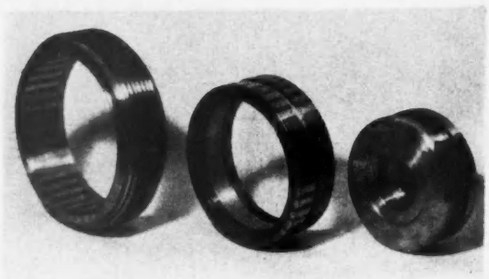

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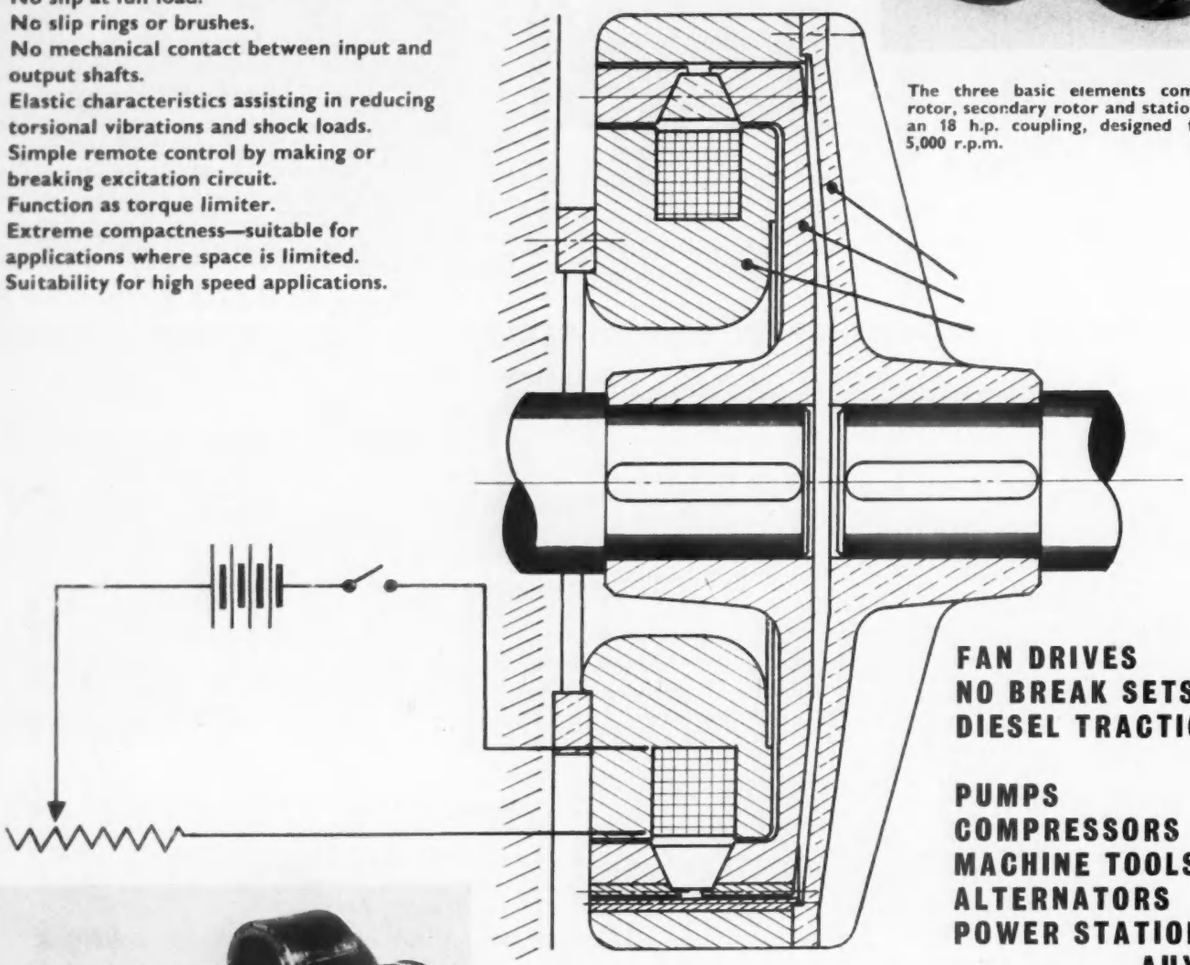

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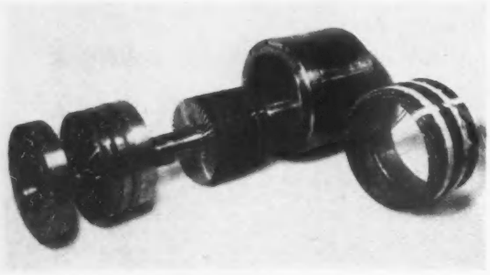

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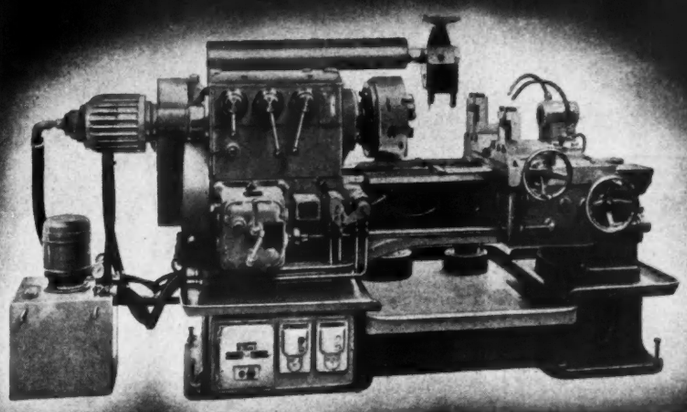

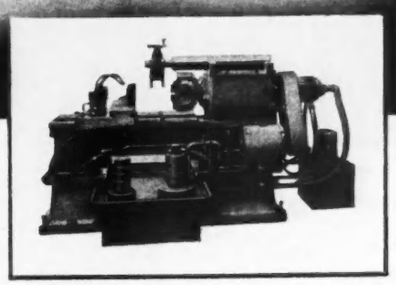

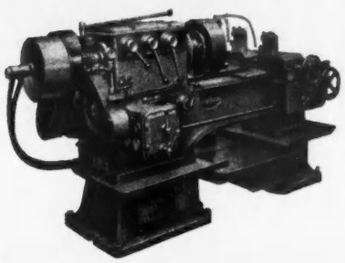

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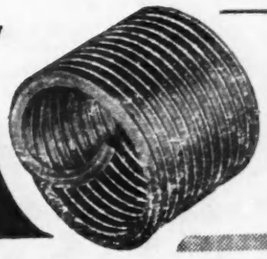

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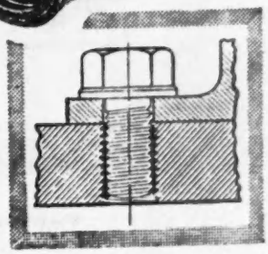

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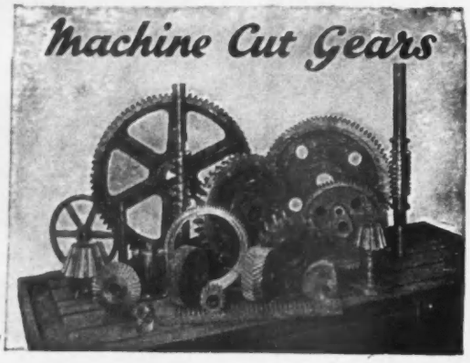

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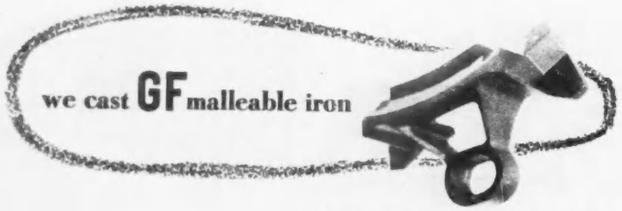

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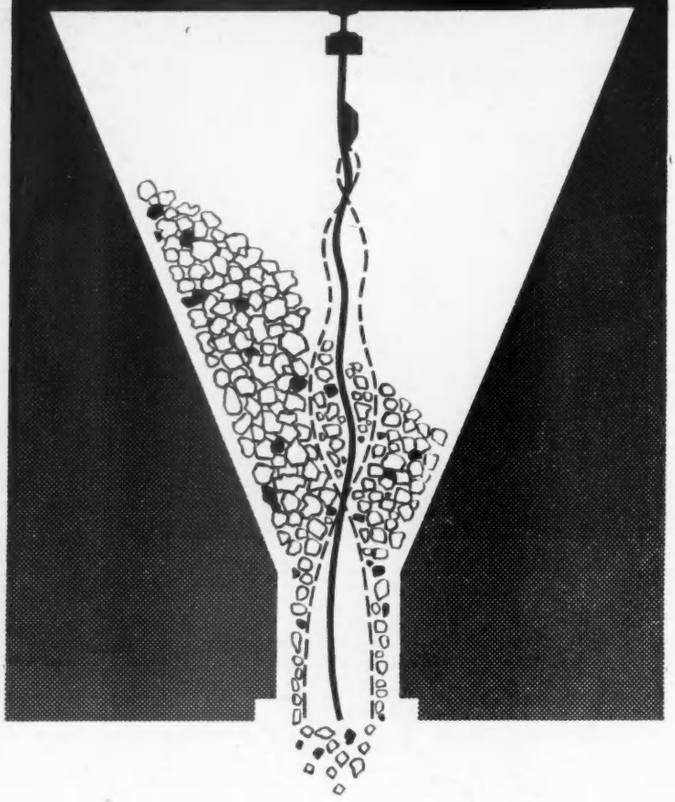

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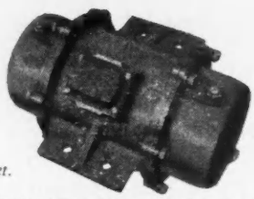

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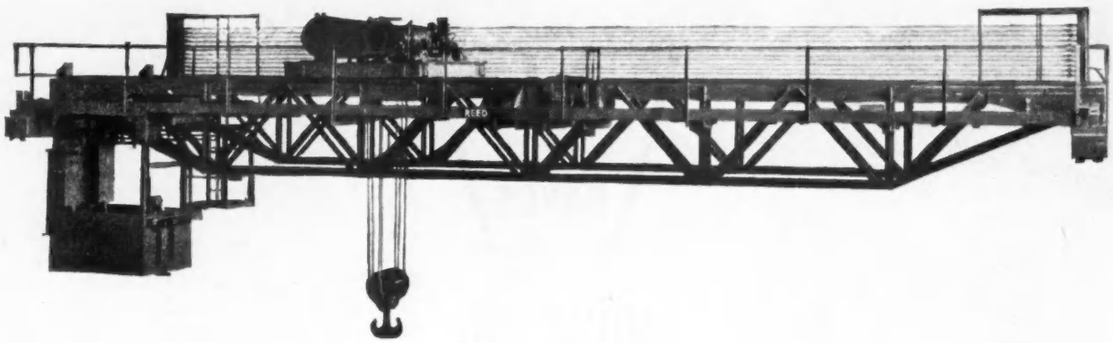
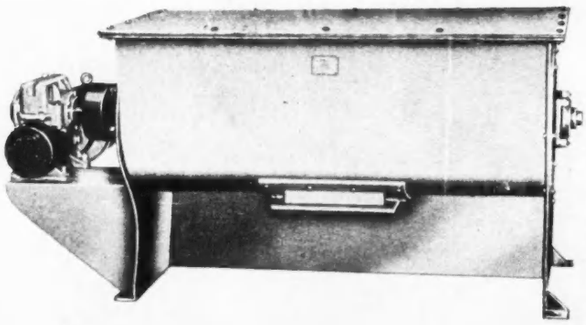


E.O.T. Cranes up to 50 tons S.W.L. and 100 ft. span
Electric Hoists up to 10 tons S.W.L.
Jib Cranes, Goliath Cranes,
Winches, Telphers & Runways

Full Catalogue sent on Request

Reed Crane and Hoist Company Limited

Lodge Causeway, Fishponds,
Bristol. Telephone : 65-3237/8 Bristol



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THIS MODERN HORIZONTAL MIXER GIVES THE MOST ACCURATE PREMIX OF SUPPLEMENTS AND FEED STUFFS AVAILABLE FROM LABORATORY SIZES UP TO 3 TONS CAPACITY

W. S. BARRON & SON LTD.
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Manufacturers with over 50 Years' experience — Offer the latest in
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MINIATURE MICRO SWITCHES AND ACTUATORS

PLEASE ASK FOR MORE DETAILS

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BURGESS PRODUCTS COMPANY LTD

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Bridges on Rubber

FIRST THIS

Road over Rail

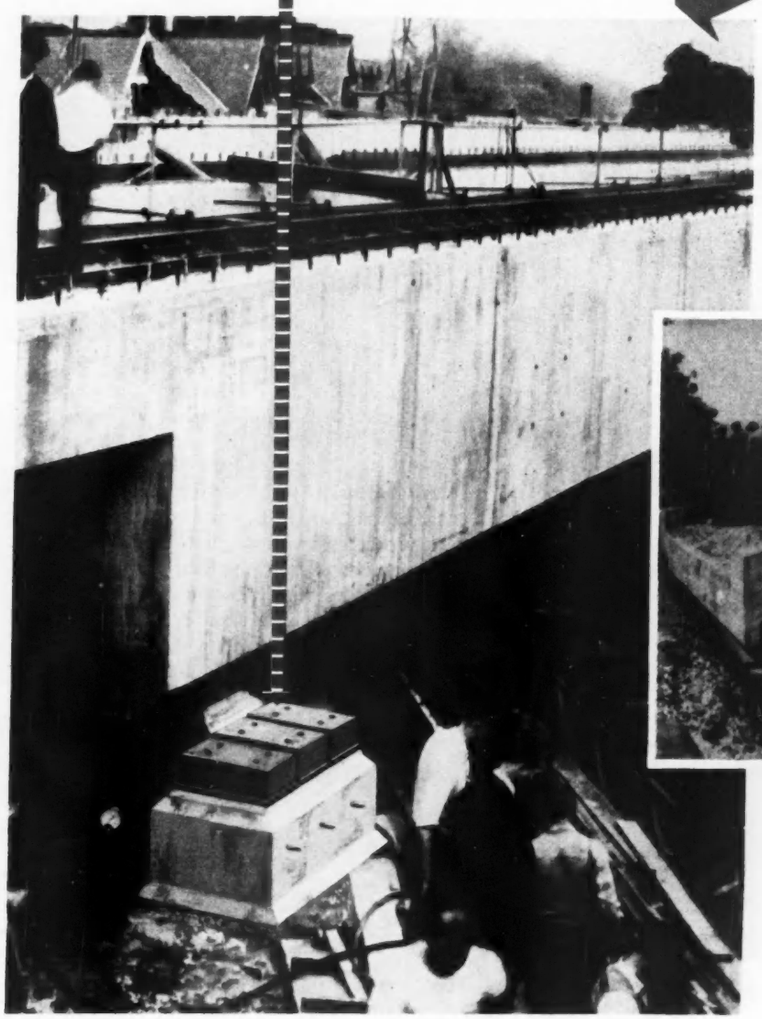
The opening of the Pelham Bridge last June marked an important step forward in bridge-building technique: this was the first major bridge in England to be supported on rubber. The rubber bearings were designed and made by the Andre Rubber Co. Ltd., who have unrivalled "know-how" and practical experience of heavy-duty rubber engineering components.

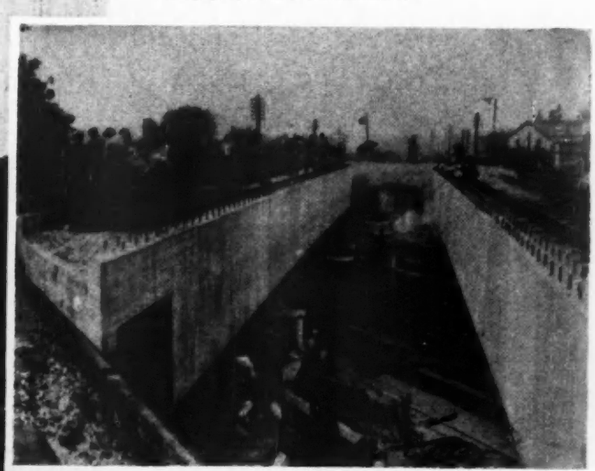
NOW THIS

Rail over Road

Andre Rubber have now produced the rubber bearings for the new Stockbridge Road bridge under construction on the London Midland Region main line to Manchester. The wide range of load fluctuations and other special problems involved in the design of this bridge were tackled successfully by the Andre Rubber team of experts.

Photograph by courtesy of British Railways





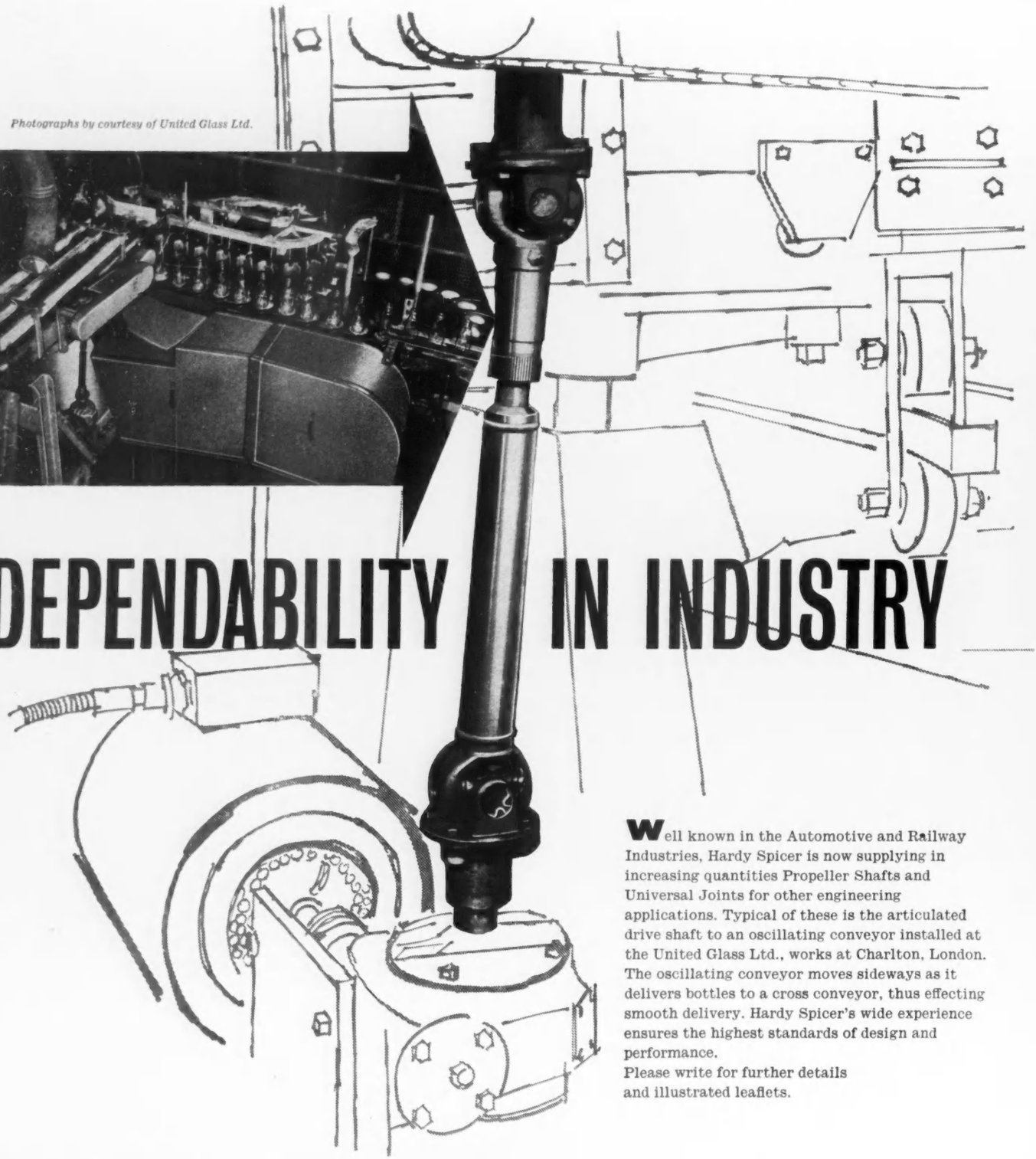
ANDRE RUBBER

A SILENTBLOC COMPANY

ANDRE RUBBER COMPANY LIMITED
KINGSTON BY-PASS SURBITON SURREY

Telephone: Elmbridge 6580/3 Telegrams: Andre Surbiton

Photographs by courtesy of United Glass Ltd.



DEPENDABILITY IN INDUSTRY

Well known in the Automotive and Railway Industries, Hardy Spicer is now supplying in increasing quantities Propeller Shafts and Universal Joints for other engineering applications. Typical of these is the articulated drive shaft to an oscillating conveyor installed at the United Glass Ltd., works at Charlton, London. The oscillating conveyor moves sideways as it delivers bottles to a cross conveyor, thus effecting smooth delivery. Hardy Spicer's wide experience ensures the highest standards of design and performance.
Please write for further details and illustrated leaflets.

HARDY SPICER

PROPELLER SHAFTS

Product of the Birfield Group

HARDY SPICER LIMITED

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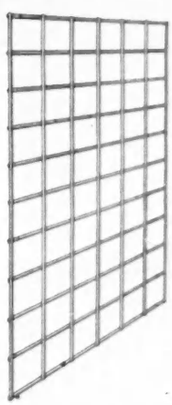
Engineering Division of BIRFIELD INDUSTRIES LIMITED, Stratford House, W.1

Weldmesh in use

...for mechanical handling

Weldmesh is the ideal material for retaining smaller components in post pallets and for racking, partitioning or machinery guards, etc. Cut it to the shape you want—it holds together because it is welded together. In the Weldmesh list of standard sizes you will find a mesh size and wire gauge to suit every purpose. A technical service is available to handle any problems.



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THE B.R.C. ENGINEERING COMPANY, STAFFORD

London, Birmingham, Bristol, Leeds, Leicester, Liverpool, Manchester, Newcastle, Cardiff, Glasgow, Dublin, Belfast, Bulawayo, Calcutta, Johannesburg, Singapore, Vancouver.

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WATER — GALLONS OF IT WHEREVER AND WHENEVER YOU WANT IT

The most efficient way to raise water is with a submersible pump—and the best submersible pump is a Beresford. Rustproof, self-lubricating, silent and utterly reliable, you can install a Beresford pump and forget it, like thousands of people before you. And there's a Beresford submersible pump to suit every need from 150 to 100,000 g.p.h. May we send you a copy of leaflet PG310?

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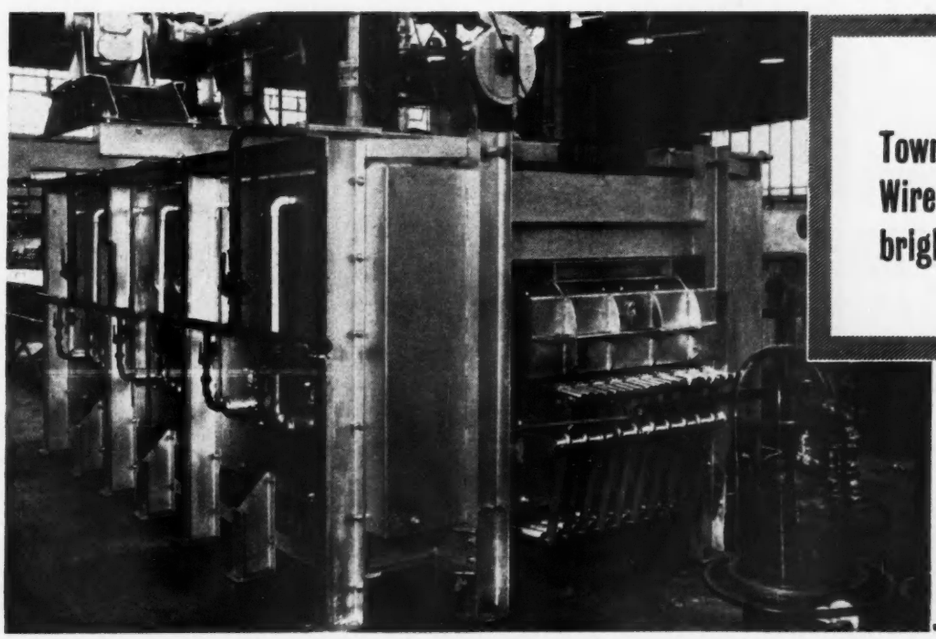

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Town's gas-fired Twenty Strand Wire Annealing Furnace for bright annealing high nickel wire of all gauges

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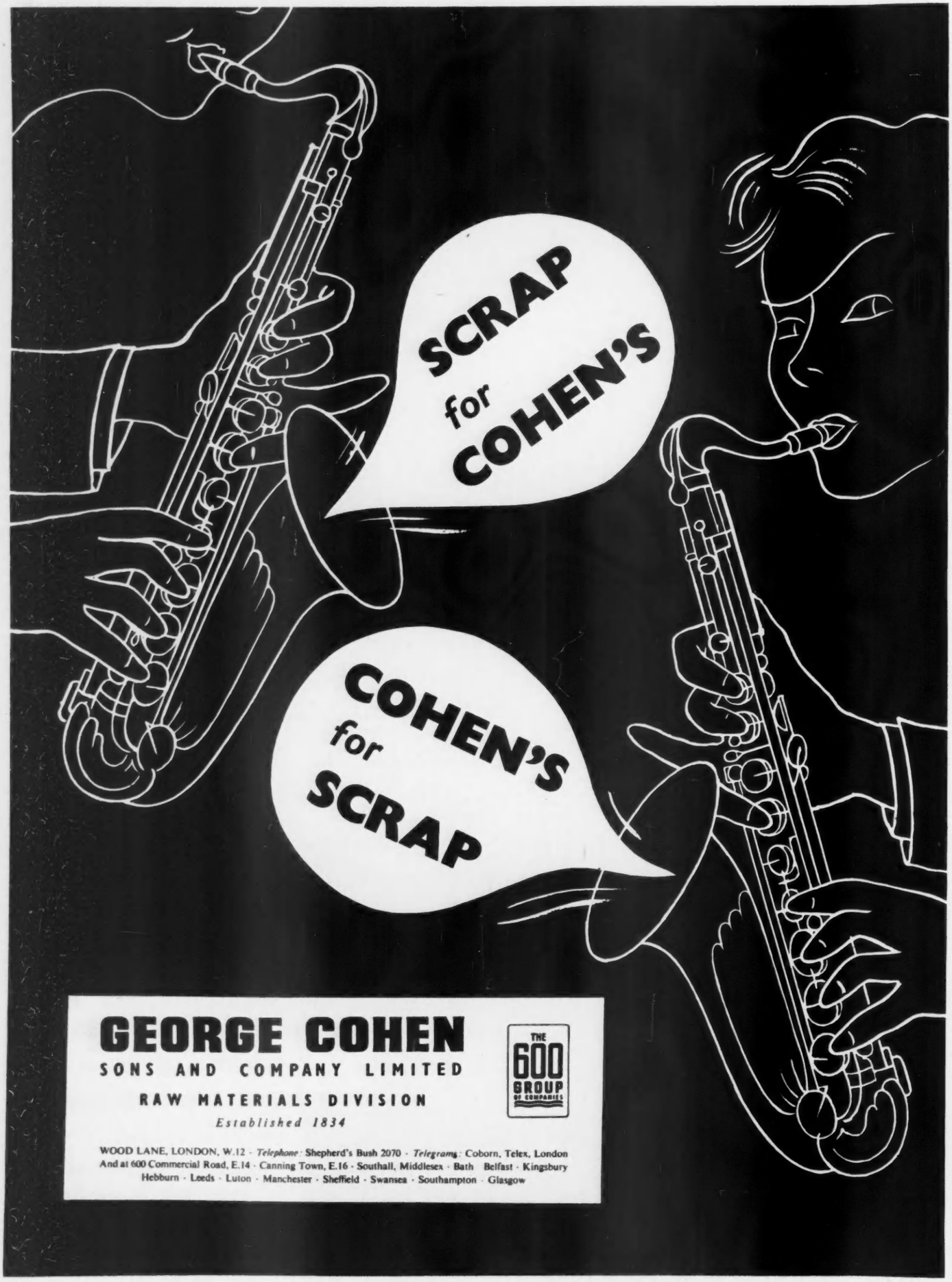
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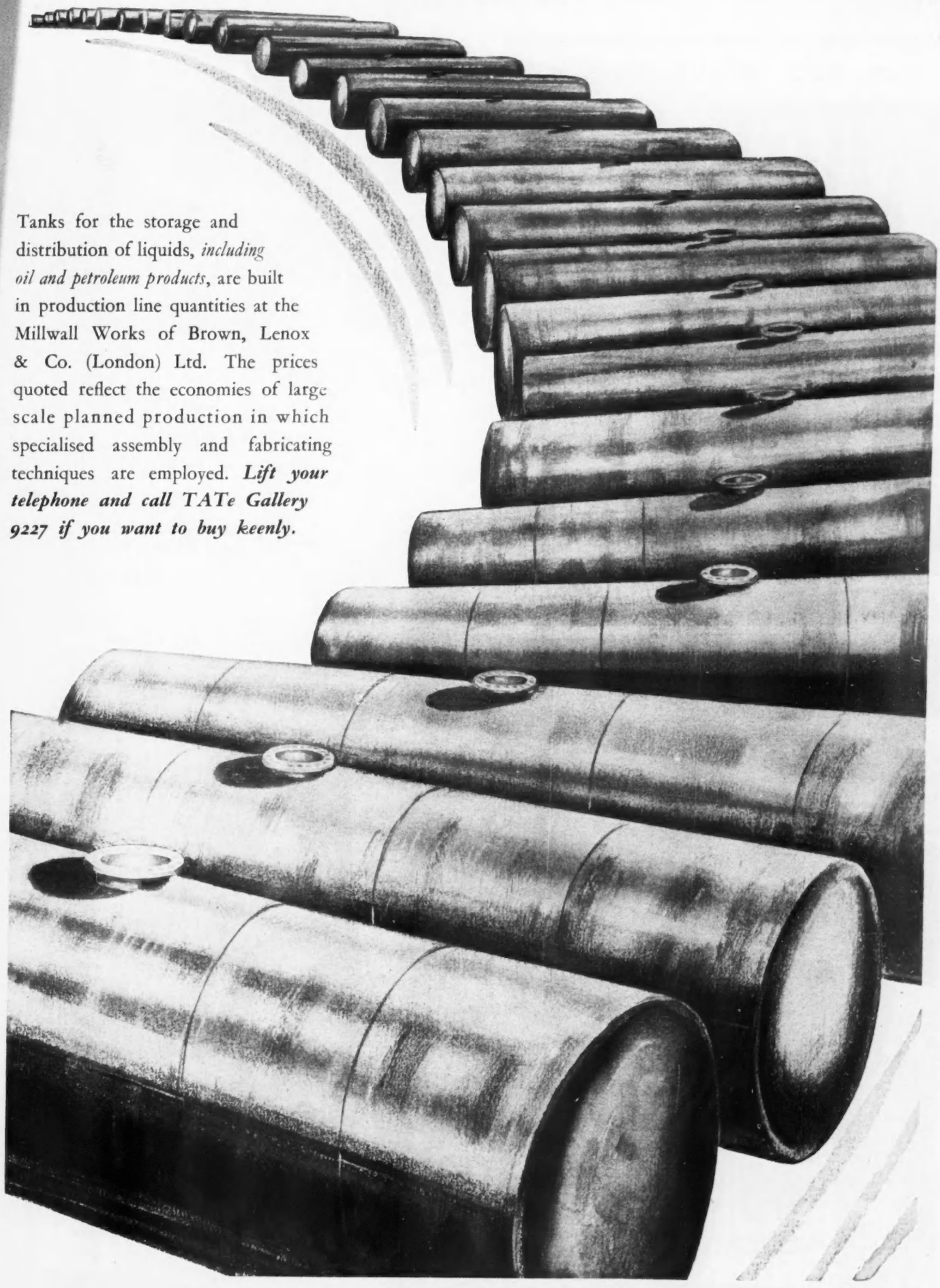
Tanks for the storage and distribution of liquids, *including oil and petroleum products*, are built in production line quantities at the Millwall Works of Brown, Lenox & Co. (London) Ltd. The prices quoted reflect the economies of large scale planned production in which specialised assembly and fabricating techniques are employed. ***Lift your telephone and call TATe Gallery 9227 if you want to buy keenly.***



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Whatever your fastening problem, Wiley can make a bolt for it—and a nut too—ask them!

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THE WALTER KIDDE COMPANY LIMITED
BELVUE ROAD, NORTHOLT, MIDDLESEX. *Viking* 6611

The illustration shows a Horseley-Piggott Pressed Steel Tank which was supplied to the Dearne Valley Water Board.

HORSELEY #1 GROUP

The Horseley Group offers a wealth of experience and extensive facilities to meet the most exacting demands of Constructional, Chemical, Civil, Gas and Water Engineering.

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BRIGHT STEEL BARS

Rounds (drawn, turned and ground)
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Supplied to A.I.D., Admiralty,
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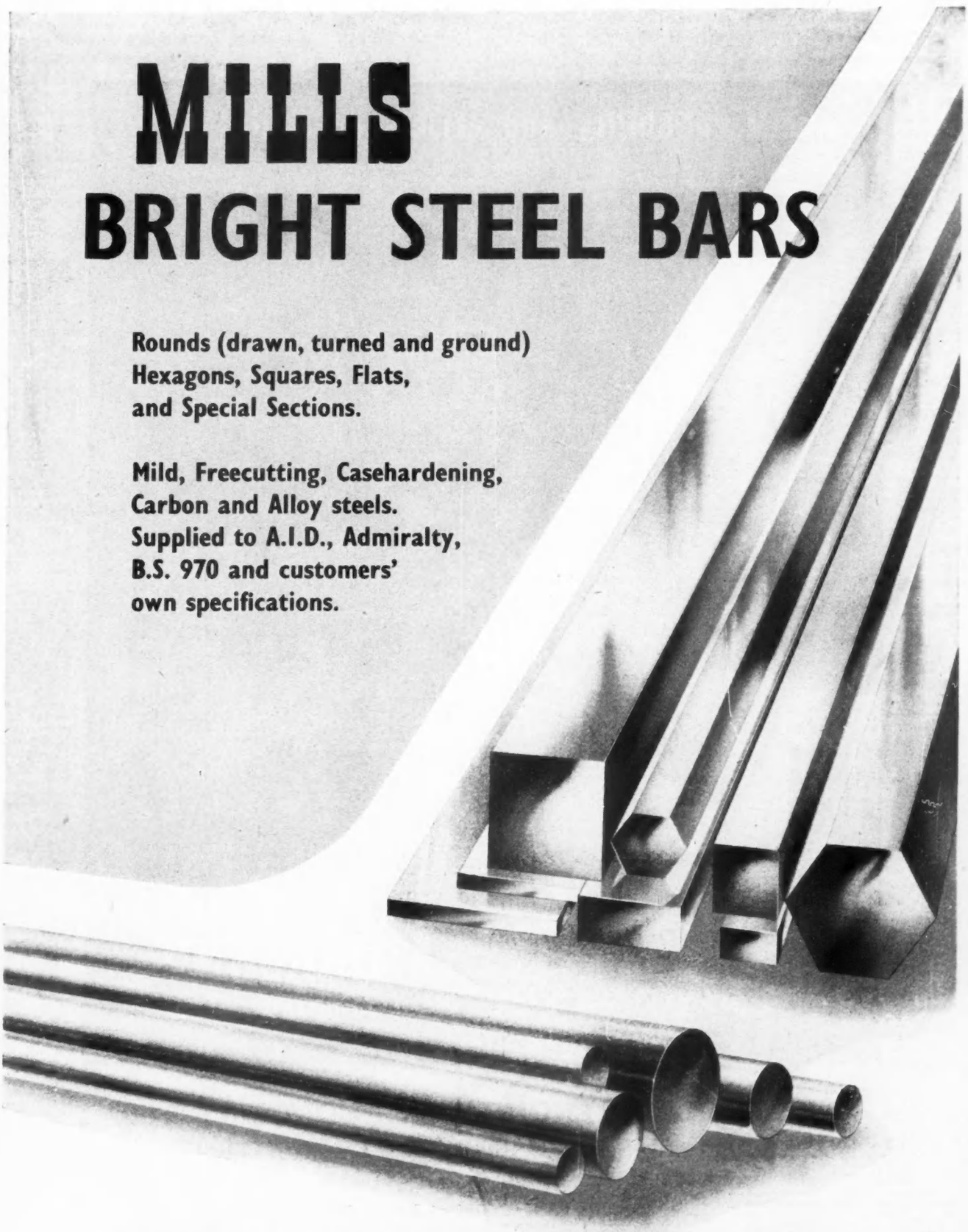

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BREDBURY STEEL WORKS WOODLEY. NR. STOCKPORT

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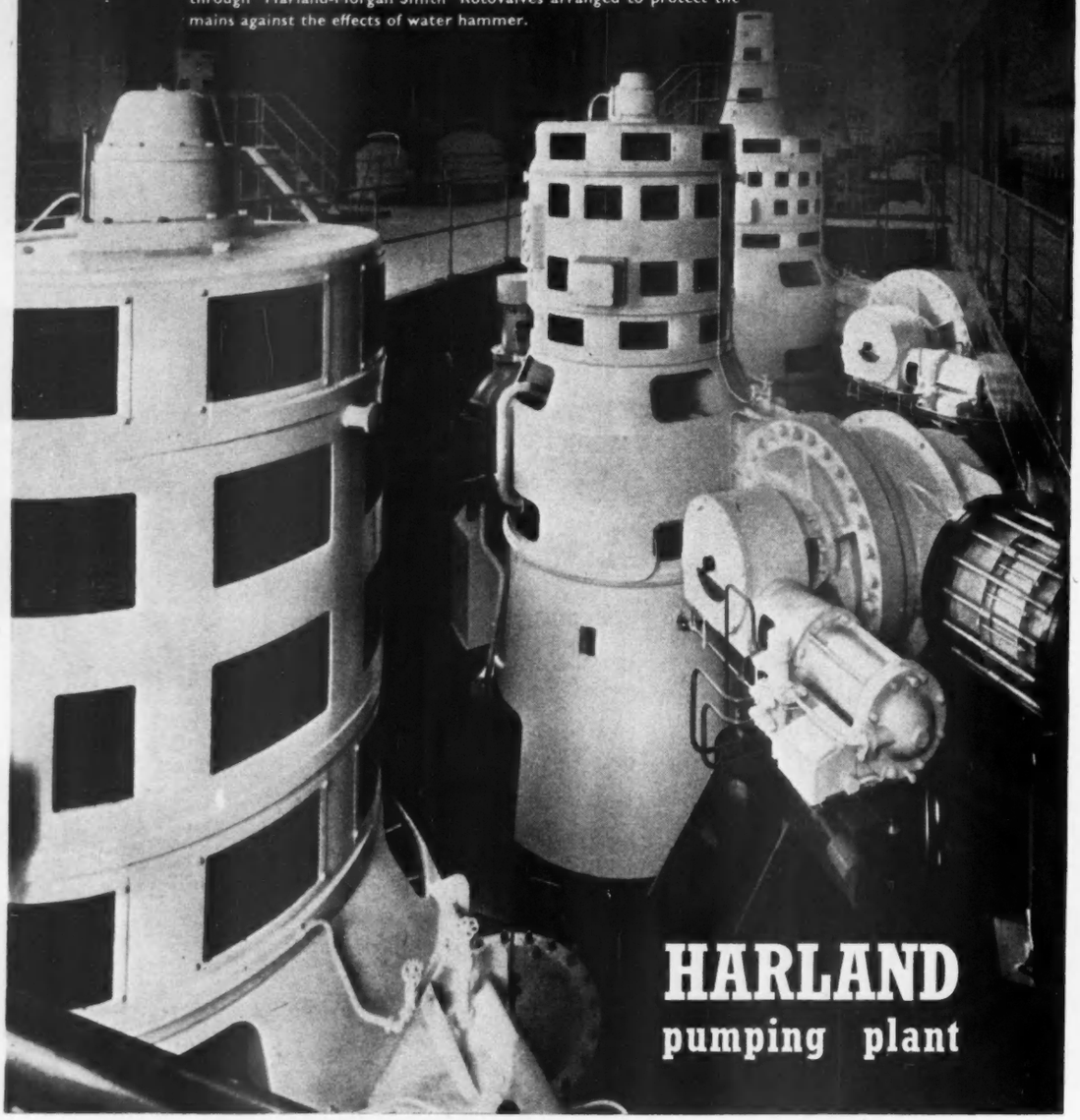
where reliability and efficiency count most

The high lift pumping plant in the Ashford Common Station of the Metropolitan Water Board consists of 12 Harland vertical Electroglides having a total capacity of 240,000,000 gallons per day. These pumpsets, which are installed in four groups each containing three units, feed through 'Harland-Morgan Smith' Rotovalves arranged to protect the mains against the effects of water hammer.



HARLAND
pumping plant

THE HARLAND ENGINEERING COMPANY LTD.

WORKS: ALLOA SCOTLAND and TIMPERLEY CHESHIRE

LONDON AND EXPORT SALES OFFICES: HARLAND HOUSE, 20 PARK STREET, LONDON W.1.

BRANCHES IN BRISTOL, GLASGOW, LEEDS, NEWCASTLE, NOTTINGHAM, TIMPERLEY (Cheshire), WOLVERHAMPTON & Overseas

A140/6

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Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and pro rata. 12 lines to 1 inch. There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

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Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

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Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to:*—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURER

Applications are invited from suitably qualified persons for appointment to a post of LECTURER in the Department of Mechanical Engineering. Qualifications must include a University Degree in Mechanical Engineering together with experience in machine-shop practice. Duties are to be assumed on 1st January, 1960, or as soon as possible thereafter.

The salary attached to the post is on the scale £1110 by £60 to £1650. An initial salary above the commencing notch of the scale may be paid if warranted on the grounds of qualifications and experience. In addition, the University is at present authorised, subject to government regulations, to pay an annual vacation savings bonus not exceeding £60.

Membership of the University Institutions Provident Fund is compulsory and involves a contribution of 7 per cent of the salary paid. Membership of the Staff Medical Aid Fund is obligatory in the case of an officer who is found eligible for membership.

Applicants are advised to obtain a copy of the information sheet relating to this vacancy from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in South Africa and London on 31st October, 1959. E7267

UNIVERSITY OF SYDNEY

CHAIR OF ELECTRICAL ENGINEERING

Applications are invited for the above position. The present occupant, Professor D. M. Myers, has recently been appointed to the position of Dean of the Faculty of Applied Science at the University of British Columbia.

Salary will be at the rate of £A3750 per annum, plus cost-of-living adjustment. There is retirement provision under the Professorial Superannuation Scheme.

Under the Staff Members' Housing Scheme, in cases approved by the University and its bankers, married men may be assisted by loans to purchase a house.

The Senate reserves the right to fill the Chair by invitation.

A statement of conditions of appointment and information for candidates may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on 21st October, 1959. E7221

UNIVERSITY OF SHEFFIELD

POSTGRADUATE DEPARTMENT OF APPLIED MECHANICS

APPOINTMENTS

Applications are invited for the following posts in the Postgraduate Department of Applied Mechanics :

(1) a LECTURER

(2) a RESEARCH ASSISTANT,

duties to begin on 1st October, 1959, or as soon as possible thereafter. Salary scales : Lecturer : £900 by £50 to £1350 by £75 to £1650 ; Research Assistant : in the range £650–£750, each post with F.S.S.U. provision and family allowance. Initial salary according to qualifications and experience. Grants towards removal expenses will be made. Further particulars may be obtained from the Registrar to whom applications (4 copies) should be sent by 19th September, 1959. E7209

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF CHEMICAL ENGINEERING

Applications are invited for the LADY TRENT CHAIR OF CHEMICAL ENGINEERING and Headship of the Department. Salary £2450 per annum, with membership of the Universities' Superannuation Scheme and children's allowances. Conditions of appointment and form of application, which should be returned by 31st October, 1959, from the Registrar. E7213

PUBLIC APPOINTMENTS

UNIVERSITY OF WESTERN AUSTRALIA

LECTURESHIP IN CIVIL ENGINEERING

Applications are invited for the above-mentioned position. The lecturer will be required to give instruction and to conduct practical classes in drawing and graphical methods to first and second year students in Engineering. He may also be required to assist in the testing laboratory. Applicants should state their field of special interest and will be expected to assist with teaching and research in that area.

Salary : £A1550–£A2050 p.a.

Conditions of appointment and general information are obtainable from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 30th October, 1959. E7212

UNIVERSITY OF TASMANIA

SENIOR LECTURESHIP IN ELECTRICAL ENGINEERING

The University invites applications for the above position. Applicants should have an Honours Degree in Electrical Engineering, together with post-graduate experience in the fields of electrical power.

The salary grade for Senior Lecturers is £A2150–£A60–£A2510, and appointment will be offered at a commencing salary within this grade according to qualifications and experience.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close in Australia and London on 31st October, 1959. E7226

UNIVERSITY OF LEEDS

DEPARTMENT OF MECHANICAL ENGINEERING

ENGINEERING DRAUGHTSMAN

Applications are invited for the post of DRAUGHTSMAN-DEMONSTRATOR. The work involves the preparation of drawings for new apparatus and assistance in the teaching of machine drawing to students. H.N.C. or similar qualification is required. Salary in the range £660 to £950, according to age and experience.—Applications in writing to Professor D. C. Johnson, Department of Mechanical Engineering, The University, Leeds, 2. E7246

KENT EDUCATION COMMITTEE

NORTH-WEST KENT COLLEGE OF TECHNOLOGY

MECHANICAL ENGINEERING DEPARTMENT

ASSISTANT (Grade B) required to teach Workshop Technology in the National Certificate course and City and Guilds course in Machine Shop Engineering. New, well-equipped laboratories. Salary £650 by £25 to £1025, plus 5 per cent.—Form of application and further details may be obtained from the Principal at the College, Miskin Road, Dartford. E7227

MIDDLESEX COUNTY COUNCIL

HEATING AND VENTILATING ENGINEER

A.P.T. IV, £1095 to £1250.

Registered initially at Westminster to act as leader of small section. Must have considerable experience in design of all branches of heating and ventilating work and be competent draughtsman in preparation of schemes, contract drawings and specifications for large Public Buildings.

Established, 5-day week, prescribed conditions, commencing salary according to qualifications and experience.

Application forms from County Architect (stamped addressed foolscap envelope), 1, Queen Anne's Gate Buildings, Dartmouth Street, S.W.1, returnable within 10 days. (Quote B.64 E.) E7233

PUBLIC APPOINTMENTS

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

REGIONAL ENGINEER'S DEPARTMENT

APPOINTMENTS

Applications are invited for the following appointments on the permanent staff of the Board generally in accordance with the Whitley Council conditions of service. London Weighting allowance of £20 to £50 p.a. in addition to salaries quoted.

ASSISTANT ENGINEERS (MECHANICAL).—Applicants should have served a recognised engineering apprenticeship and must be Graduate Members of the Institution of Mechanical Engineers, and have passed A and B of the Associate Membership examination, or hold exempting qualifications. Corporate Membership of the Institution of Heating and Ventilating Engineers will qualify. Sound experience of design of mechanical services of large buildings required. Drawing-office and estimating experience an advantage.

Salary £730 by £25 (2) by £30 (5) by £40 (1) to £1055 p.a. Commencing salary above the minimum of the scale for relevant practical experience.

ENGINEERING ASSISTANT (MECHANICAL).—Commencing salary within the scale (Grade II), £545 by £20 (3) by £25 (4) by £30 (2) to £765 p.a. for candidates possessing O.N.C. or equivalent, or (Grade I), £680 by £25 (3) by £30 (1) by £35 (4) by £40 (2) to £1005 p.a. for candidates possessing H.N.C. or equivalent.—Application forms may be obtained from the undersigned at 40, Eastbourne Terrace, London, W.2, opposite Paddington Station, and must be returned completed by not later than 14th September, 1959.

E. G. BRAITHWAITE,
Secretary.
E7225

WEST CUMBERLAND HOSPITAL MANAGEMENT COMMITTEE

WEST CUMBERLAND HOSPITAL, WHITEHAVEN

SENIOR ENGINEER

Applications are invited for the appointment of SENIOR ENGINEER at the new West Cumberland Hospital, which is now under construction, the first stage being due to be occupied in December, 1959. The Senior Engineer will be responsible to the Superintendent Engineer for the operation of the fully automatic, unattended, oil-fired boiler plant, and for the other engineering services, including the Group laundry, in the hospital, including the Homewood Annexe.

Whitley Council conditions ; salary scale £680–£815. A house will be available at a reasonable rent.

Applications, from persons trained in mechanical engineering and holding a First Class Certificate of Competency in Marine Engineering, or a Certificate of Service as a First Class Engineer, or a City and Guilds Full Technological Certificate in Plant Engineering (First Class), giving full details of qualifications, experience, and the names of three referees, should be forwarded to the Group Secretary, Workington Infirmary, Workington, Cumberland. E7253

BRITISH TRANSPORT DOCKS

HUMBER PORTS, HULL

ASSISTANT CHIEF DOCKS ENGINEER

British Transport Docks invite applications for the post of ASSISTANT CHIEF DOCKS ENGINEER, Humber Ports, Hull.

The successful applicant will be responsible to the Chief Docks Engineer, Humber Ports, for all mechanical and electrical engineering matters. Applicants for the position should have a wide knowledge of the design, construction and maintenance of all types of docks mechanical and electrical equipment, including drydock pumping installations, cranes, electrical substations, distribution and switchgear and of the control of maintenance and operating staff conneced therewith. Corporate Membership of the Institution of Mechanical and/or Electrical Engineers is essential. Salary £1930–£2350 per annum. Superannuation scheme (contributory) and certain free travel facilities.

Applications, stating age, particulars of education, experience and qualifications should be forwarded to Staff and Establishment Officer, British Transport Docks, 163, Euston Road, London, N.W.1, not later than Tuesday, 15th September, 1959. E7245

PUBLIC APPOINTMENTS

THURROCK URBAN DISTRICT COUNCIL

(POPULATION 110,000—RAPIDLY INCREASING)

ENGINEER AND SURVEYOR'S DEPARTMENT

APPOINTMENTS

(a) ASSISTANT ENGINEER. Salary : A.P.T. IV, £1065 to £1220 per annum. Applicants should be Chartered Civil or Municipal Engineers, or have equivalent qualifications and have extensive civil engineering experience, and should be capable of designing and supervising construction of major schemes. In particular, experience is desired in sewerage and sewage disposal. Housing accommodation may be considered if successful candidate resides more than 20 miles from Thurrock.

(b) Two ENGINEERING ASSISTANTS. Salary : A.P.T. I/II, £610 to £880 per annum. Applicants should have completed their training in a Municipal or Civil Engineers' office and have had some subsequent experience.

Appointments pensionable.

Applications, stating age, qualifications and experience, and quoting three referees, to the Clerk of the Council, Council Offices, Grays, Essex, by 8th September, 1959. Canvassing disqualifies. Relationship with members or senior officers of the Council must be disclosed. E7149

ST. DAVID'S HOSPITAL, CARMARTHEN

ASSISTANT ENGINEER

ASSISTANT ENGINEER required at St. David's Hospital, Carmarthen (1016 beds).

Applicants must have served a recognised engineering apprenticeship and have a sound knowledge and experience of steam boiler plants and auxiliaries, heating and domestic hot water apparatus and electric installations.

Candidates should possess the Ordinary Engineering Certificate in Mechanical Engineering (including heat engines and the principles of electricity), or an equivalent qualification.

Salary and conditions of service for this post, which is superannuable, will be in accordance with the Whitley Council recommendations, £605 by £25 (3) by £30 (2) to £740 per annum.

The successful candidate will be required to reside near the hospital. Unfurnished flat available.

Applications, giving details of age, qualifications and experience, and quoting the names and addresses of three referees who can testify to professional ability, should be forwarded to the Secretary, St. David's Hospital, Carmarthen, by September 25th. E7216

CIVIL SERVICE COMMISSION

POST OFFICE

ASSISTANT ENGINEER AND TELECOMMUNICATIONS TRAFFIC SUPERINTENDENT

(a) ASSISTANT ENGINEER (at least 15 posts for men) ; (b) TELECOMMUNICATIONS TRAFFIC SUPERINTENDENT (about 10 posts for men and women). All pensionable. Age on 1st March, 1959 : 17½ and under 23½ for (a), 24½ for (b) ; with extension for Forces service, Overseas Civil Service, and (up to two years) established civil service. Duties : (a) technical design and development of telecommunications equipment, (b) planning and management of telephone services. Qualifications for (a) and (b) : G.C.E. (or equivalent) in English Language and 4 other subjects, including 2 at "A" level obtained at same examination from Pure Mathematics, Applied Mathematics, Pure and Applied Mathematics, Physics, Chemistry ; or (for (a) only) H.N.C. or H.N.D. in Electrical or Mechanical Engineering, or C. and G. Final Grouped Course Certificate in Telecommunications. Selection by interview. Salary (London, men) : (a) £555 at 18, 19, 20, £615 at 21, £745 at 25 or over, rising to £1105 ; (b) £532 at 18, £552 at 20, £700 at 25 or over, rising to £1085. Promotion prospects. Write Civil Service Commission, Burlington Gardens, London, W.1, for application forms, quoting (a) 291/59, (b) 303/59. Closing date 10th September, 1959. E7230

Classified Advts. continued on page 146

PUBLIC APPOINTMENTS

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Vacancies for SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in following localities: LONDON AREA : MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics to carry out research programme in a particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles : knowledge of theoretical hydrodynamics and theory of control systems an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICISTS for acoustic analysis. ELECTRONIC PHYSICISTS for data handling and analysis problems. PHYSICIST interested in operator performance. CLASSICAL PHYSICISTS.

BALDOCK : PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH : ELECTRONIC ENGINEERS for research on analogue computers and transistor circuits. ELECTRICAL ENGINEERS for research on small rotating electrical machinery. PHYSICISTS—for optical systems and instrumentation. ELECTRO-MECHANICAL ENGINEERS — for work on servo-mechanisms.

PORTLAND : PHYSICISTS or APPLIED MATHEMATICIANS for research on underwater acoustics. ELECTRONIC PHYSICISTS, ELECTRONIC ENGINEERS—for design work. PHYSICAL CHEMISTS.

POOLE : CHEMICAL ENGINEERS. CHEMISTS for work on rubber technology.

ROSYTH : PHYSICISTS—(Electronic).

Candidates must normally be natural born British subjects of natural born British parents, with First or Second Class Hons. Degrees, S.S.Os. must have had three years' post-graduate experience and be not less than 26 years of age. Salaries (men) : S.S.O., £1233–£1460 ; S.O., £655–£1150 (London), somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.220/9A). E7037

CITY OF LIVERPOOL

BATHS AND WASH-HOUSES DEPARTMENT

SENIOR ASSISTANT (ENGINEERING)

Applications are invited for the appointment of SENIOR ASSISTANT (ENGINEERING). Salary : £1065 to £1220 per annum (A.P.T. IV).

Applicants must possess the Higher National Certificate in Mechanical Engineering and should preferably be a Corporate Member of an appropriate engineering Institution. They must have had general experience including the planning, operation and maintenance of boiler, steam, water, heating, lighting, laundry and filtration plant.

Application form, returnable by 28th September, 1959, obtainable from the Baths Manager and Engineer, 62, Fontenoy Street, Liverpool, 3.

The appointment is superannuable and subject to the Standing Orders of the City Council. Canvassing disqualifies.

THOMAS ALKER,
Town Clerk.
(J.5791) E7210

LEICESTER ROYAL INFIRMARY

ASSISTANT ENGINEER

Applications are invited for the post of ASSISTANT ENGINEER. Salary on the scale £575–£700. The successful applicant will be directly responsible to the Superintendent Engineer and may either be required to take direct charge of the maintenance and operation of the engineering plants of several small hospitals or to assist the Senior Engineers at the larger hospitals in the group. He will be required, with other engineers, to take part in an " On Call " rota. Applicants must have completed an apprenticeship in, or have a sound, practical knowledge of, mechanical engineering. Preference will be given to applicants with the O.N.C. in Mechanical Engineering, which includes heat and heat engines.

Applications, stating age, qualifications and experience, together with the names of three referees (who should be present and/or past employers), to the Group Secretary, The Leicester Royal Infirmary, within fourteen days of the advertisement. E7268

GOVERNMENT OF BARBADOS

WATERWORKS DEPARTMENT

ASSISTANT ENGINEER (ELECTRICAL)

Responsible under the Chief Engineer for installation, operation and maintenance of electrical machinery in the Waterworks Department and to advise on specifications for new electrical plant.

Permanent appointment or contract appointment with gratuity. Salary up to £1300. Passage assistance.

Candidates must be A.M.I.E.E. or Grad. I.E.E., with at least 5 years' practical experience in the maintenance and installation of motors, switchgear and generators. Experience in diesel-driven generators an advantage.

Write, Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 140/28/02. E7251

PUBLIC APPOINTMENTS

SOUTH OCKENDON HOSPITAL, NEAR ROMFORD AND GRAYS, ESSEX

SENIOR ENGINEER

Applications are invited for the post of SENIOR ENGINEER at the above hospital for mentally handicapped. Candidates must have completed an apprenticeship in mechanical engineering or have otherwise acquired a sound practical training in mechanical engineering ; operation of hospital boiler plants, including chain grate stokers, kitchen and laundry machinery, motor transport and possess electrical engineering experience. The successful applicant should have passed an examination in engineering technology, and hold one of the following qualifications or approved equivalent, viz. M.T.C.A. First Class Certificate of Competency in Marine Engineering ; M.T.C.A. Certificate of Service as First Class Engineer ; City and Guilds full Technology Certificate in Plant Engineering (First Class), National Certificates (Mech.) or Diplomas.

Pointrage range (10¼ to 20 points) but shortly rising to (20½ to 30 points). Salary at present £680 to £815 per annum and Whitley Council conditions of service. Staff house available at a moderate rental in which the successful candidate may be required to reside.

Applications to the Group Secretary to the Committee, Leytonstone House, High Road, London, E.11, stating full names, address, date of birth, present and past appointments, commercial and hospital experience and qualifications, together with names and addresses of two referees, by 14th September, 1959. E7238

SCOTTISH GAS BOARD

LURGI PRESSURE GASIFICATION PLANT, WESTFIELD, FIFE

MECHANICAL ENGINEER

Applications are invited for the post of MECHANICAL ENGINEER at the large, modern Lurgi Pressure Gasification project under construction by The Scottish Gas Board at Westfield, Fife. The Mechanical Engineer will be responsible to the Works Engineer for the maintenance of all works plant and machinery.

Applicants must be Corporate Members of the Institution of Mechanical Engineers (or hold an equivalent qualification), and should have experience in all maintenance aspects of high pressure chemical plant and machinery (including welding of pressure vessels to accepted standards) preferably in relation to oil refinery practices. Electrical experience and experience of preventative maintenance and inspection systems will be an advantage.

Salary on a scale £1483 per annum rising to £1683 per annum, with initial placing according to qualifications and experience.

The post is pensionable and the successful applicant will be required to pass a medical examination.

Applications stating age and giving details of education, training, quali cations and experience, together with the names of two referees, should be sent to the undersigned within ten days of the appearance of this advertisement.

A. T. HERD,
Secretary,
26, Drumsheugh Gardens,
Edinburgh, 3. E7208

WEY VALLEY WATER COMPANY

CIVIL ENGINEERING ASSISTANT

CIVIL ENGINEERING ASSISTANT, commencing salary £750–£850 per annum, with annual increments, plus car allowance.

Applications are invited for the above appointment on the permanent staff of the Wey Valley Water Company.

Qualifications : applicants must have been trained as civil engineers and have either passed Parts I and II of the Institution of Civil Engineers' examination or hold a University Degree. Preference will be given to those who have had experience in the office of a water engineer.

The applicant should hold a licence to drive a car. The appointment is permanent and pensionable.

Applications, stating age, qualifications, present position and salary, and giving an account of his education, training and experience, should be sent to the Engineer and Works' Manager, Wey Valley Water Company, 3, Downing Street, Farnham, Surrey, not later than 30th September, 1959. E7243

TENDERS

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

	Quantity, tons
Deep/extra deep drawing quality SHEETS, 48in. × 20¼in. × 20 B.G.	685

Forms of Tender may be obtained from the above address on or after the 4th September, 1959, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to " High Commissioner for India." Tenderers must send their Tender so as to reach this Office latest by 2 p.m. on Thursday, 15th October, 1959.

Please quote reference No. 47/58.DB/RLY.2. E7219

EDUCATIONAL

UNIVERSITY OF MANCHESTER

THE NEXT SESSION COMMENCES ON TUESDAY, 13th OCTOBER, 1959. E7029 E

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

ASSISTANT CHIEF ENGINEER

required by old-established Company manufacturing heavy cranes and allied equipment. Salary £1850. Pension. Applicants must have worked for two or three unrelated companies, including four years on cranes, have served a workshop and drawing-office apprenticeship, have A.M.I.Mech.E. or Degree and be between 32 and 42 years of age. The Chief Engineer will open all applications and treat them as strictly confidential.—BOX No. E2527, " The Engineer." A

DESIGN DRAUGHTSMAN

Section Leader for interesting work in connection with Chassis and Mobile Crane design. Experience with Hydraulic Equipment desirable.

SENIOR DRAUGHTSMAN

with good experience in general engineering, knowledge of electric power and control equipment essential. Required to work on mobile cranes and special types of mining Equipment.

Both the above posts are offered on a permanent basis, with contributory pension scheme and canteen facilities. Apply.—BOX No. E7254, " The Engineer." A

DESIGN ENGINEER.—An engineer is required by Imperial Smelting Processes, Ltd., to participate in the design and development of furnaces and ancillary plant for the Imperial Smelting blast furnace process for the simultaneous smelting of zinc and lead. Applications are invited from qualified engineers, preferably possessing a First Class Honours Degree, together with sound experience, including design, in the heavier type of engineering. In addition, fluency in both written and spoken German is essential and, with this in mind, consideration will be given to foreign nationals possessing this facility, provided their command of English is adequate. Applicants should be under 36 years of age and must be prepared to travel abroad if required.—Write for application form to Personnel Manager, Imperial Smelting Corporation Limited, St. Andrew's Road, Avonmouth, Bristol, quoting ref. DG/TE. E7232 A

DESIGNER-DRAUGHTSMAN required, preferably with H.N.C. in Mechanical Engineering. Non-contributory pension scheme available.—Applications to Metalectric Furnaces, Ltd., Cornwall Road, Smethwick, 40, Staffs. E2512 A

DRAUGHTSMAN required. Experience in mechanical handling plant and structures an advantage. Good prospects.—British Industrial Sand, Ltd., High Street, Godstone, Surrey. E161 A

DRAUGHTSMAN required for design and detail work on small Water-tube Boilers, also Pressure Vessels, Chimneys and Ductwork, &c., Pension Scheme. 5-day week. State age, experience and salary to—Fraser and Fraser, Ltd., Bromley-by-Bow, E.3. E2528 A

ELECTRICAL ENGINEER

This vacancy offers a Grad.I.E.E. an opportunity to further his experience in heavy power plant, particularly with reference to the Cross Channel D.C. Transmission.—Apply, stating age, experience, education, present salary, to Fuller Electric Ltd., Walthamstow, E.17. E7234 A

ENGINEER capable of designing in steel, conerete and prestressed concrete, and well versed in marine and general structures, required by Consulting Engineers.—Apply to Sir Bruce White, Wolfe Barry and Partners, 1, Lygon Place, Grosvenor Gardens, London, S.W.1 (Tel.: Sloane 3433). E7250 A

ENGINEERS required for commissioning and operating duties on large power station water-tube boilers in Provinces. Previous water-tube boiler experience desirable, while applicants should have an engineering qualification. Salary, £800 p.a. Adequate hotel and travel allowances. Write fully, stating age, qualifications and experience.—BOX No. E7228, " The Egineer." A

FOR A LEADING STEEL FOUNDRY IN INDIA, a FOUNDRY MANAGER with extensive experience of Metallurgy, Methods, Costing, Estimating, Sales and Development of new items, should be capable of negotiating at all levels including Government. Can be given charge of the factory including electric furnaces and machine shops. Very good prospects for enterprising experienced executive. Age not less than 45.—BOX No. E7265, " The Engineer." A

HONOURS GRADUATES IN ENGINEERING AND SCIENCE required, for fundamental research on machine tools and manufacturing techniques. Excellent working conditions and prospects. Good commencing salary with annual increments on merit. Superannuation under F.S.S.U.—Applications to the Secretary (R.579), Production Engineering Research Association, Melton Mowbray, Leics. E7231 A

SITUATIONS VACANT

HICK, HARGREAVES AND CO., LTD., SOHO IRONWORKS, BOLTON,
have vacancies for
SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN
for interesting work on large Power Station condensing and feed heating plant. Experience in this type of work is desirable but not essential. Candidates with H.N.C. or equal will be preferred. Practical experience is essential, together with a sound knowledge of pressure vessels and piping layouts.

Pension Scheme carrying free insurance.
Good canteen facilities.
Five-day week.

Applications, stating details of age, experience and salary expected, should be addressed to the CHIEF DRAUGHTSMAN.

E2509 A

MACHINE TOOL DESIGNER DRAUGHTSMAN
required by
MIDGLEY AND SUTCLIFFE, LTD., LEEDS, 10

An unusual opportunity to participate in interesting development work available to a capable man with ideas together with a sound training and technical qualifications appropriate to this type of engineering.

The appointment is permanent and pensionable.—Applications should be made in writing to the Personnel Officer, Geo. Cohen 600 Group, Ltd., Stanningley, Nr. Leeds.

E7261 A

MAJOR ORGANISATION REQUIRES :

1. ARCHITECTURAL ASSISTANTS.
2. STRUCTURAL ENGINEERING DESIGN DRAUGHTSMEN.
3. DESIGN and INTERMEDIATE DRAUGHTSMEN experienced in one of the following :—
   (a) Air conditioning.
   (b) Heating and ventilating.
   (c) Plumbing, and
   (d) Sanitation.

Well experienced persons are required immediately for these interesting posts, in London Division. Salaries offered are HIGH. Please reply, with particulars of experience and qualifications, to Managing Director, Ref. X1, BOX No. E7190, " The Engineer." A

MECHANICAL ENGINEER

required by the National Coal Board's Coal Research Establishment, at Stoke Orchard, near Cheltenham, Glos., to lead a research group responsible for design, development and installation of mechanical and hydraulic machinery for use in the Coal Industry. A wide general experience of mechanical engineering, together with a good honours degree, or equivalent in that subject is required. Appointment superannuable ; and salary according to qualifications and experience within £1375–£2150. —Write with full details to Staff Department (X.1342/4.E), N.C.B., Hobart House, London, S.W.1, before 16th September, 1959.

E7262 A

NATIONAL COAL BOARD : NORTH WESTERN DIVISIONAL HEADQUARTERS.
—ASSISTANT DIVISIONAL PURCHASING OFFICER, Purchasing and Stores Department. Salary scale £1000 by £40 to £1325. Successful candidate will be concerned with commercial aspects of negotiation of contracts for mechanical and electrical plant. Applicants should have experience of such work, including pricing and analysis of contracts.—Applications, giving age, education, experience, present post and salary, to the Divisional Chief Staff Officer, 40, Portland Street, Manchester, 1, within 10 days. E7224 A

REINFORCED CONCRETE ASSOCIATION.
—Due to the approaching retirement of the Secretary, applications are invited for the post. Candidates should have administrative experience and, preferably, some technical knowledge.—Applications, giving particulars of qualifications and experience, should be addressed to The President, The Reinforced Concrete Association, 94–98, Petty France, London, S.W.1. E7218 A

SALES EXECUTIVE, to take charge of London office of printing machine manufacturers. Applicants should have experience of machinery sales and have the personality and initiative to develop sales of new types of machines. Experience in the printing machine industry and technical qualifications preferred but not essential. Pension and excellent prospects for right man. Reply in confidence, stating age, chronological details of experience and salary required, to Managing Director.—BOX No. E7157, " The Engineer." A

SENIOR CRANE DESIGNER required in West Riding, Yorkshire, with sound knowledge of overhead travelling cranes. Interesting and varied work with good prospects. House provided if necessary. Give full details of experience and salary required.—BOX No. E7220, " The Engineer." A

SENIOR PROJECT ENGINEER with exceptional experience in the design and modern development of a range of punching, shearing and guillotine machines. The position offered is permanent, progressive and pensionable. The location is near Manchester. A suitable salary is offered to a man with vision and initiative.—Apply BOX No. E7264, " The Engineer." A

SENIOR SALESMAN required to operate in the Greater London area, dealing with the sale of Overhead Electric Travelling Cranes up to 100-ton capacity. Applicants should have had previous experience in this field and if possible should have had design and manufacturing experience. First-class prospects of advancement, car provided, pension scheme. Applications.—BOX No. E7248, " The Engineer." A

SITUATIONS VACANT

SIR WILLIAM ARROL AND CO., LTD., 85, Dunn Street, Glasgow, S.E., require STRUCTURAL STEELWORK DESIGNERS with varied experience. Five-day week and pension scheme.—Apply, stating qualifications, details of experience and salary required. E7249 A

SITE CIVIL ENGINEERS (2) required for project in Kuwait. Preference will be given to those who are Corporate Members of the Institution of Civil Engineers. A good salary will be paid and there is generous home leave on completion of tour. Bachelor accommodation only, minimum age 25. No income tax is payable in Kuwait.—BOX No. E7269, "The Engineer." A

STRUCTURAL DESIGNER required for work on important and interesting structures of steel lattice construction. Qualifications at least to H.N.C. and good experience in steel construction essential. Age 23 to 27.—Apply, giving all details and salary required, to Personnel Officer (Staff), British Insulated Callender's Construction Company, Limited, 21, Bloomsbury Street, London, W.C.1. E7182 A

SITE ENGINEER required to supervise the installation of a number of large Air Conditioning Schemes in West Africa. Wide practical experience of the erection of pipe and duct work and the installation of machinery essential, together with the ability to control semi and unskilled labour. Some experience of Refrigeration and Electrical work would be useful. A substantial salary with free accommodation will be offered during the course of the contract which is expected to last about twelve months. On satisfactory completion there will be the possibility of re-engagement on contract terms or of permanent employment.—Apply to Manager, Staff Dept., BOX No. E7258, "The Engineer." A

STRUCTURAL STEELWORK DESIGNER/DRAUGHTSMAN required for interesting and varied work on building frameworks, industrial steelwork and mechanical handling plants. Age 25–30. Permanent position, excellent prospects, good salary, five-day week, pension scheme.—Apply, stating qualifications and experience, to (Ref. CW) Robt. Cort and Son, Ltd., Reading Bridge, Reading. E7164 A

SURVEYOR (LAND) required, to carry out surveys for industrial development schemes, setting out of structural steelwork and checking civil engineering works. Good starting salary, five-day week, pension scheme, excellent prospects, with opportunity to train as Structural Steelwork Designer. Age 23–28.—Apply, stating details of experience, to Robt. Cort and Son, Ltd., Reading Bridge, Reading. E7163 A

THE CHESTERFIELD TUBE COMPANY require a DESIGNER DRAUGHTSMAN preferably experienced in medium and heavy engineering handling equipment. Excellent opportunities and scope for the right man. Salary according to qualifications and experience, permanent position, five-day week, contributory pension scheme, canteen facilities, &c.—Apply, stating age, details of past experience and salary required, to Personnel and Welfare Department, Derby Road, Chesterfield. E7171 A

UNILEVER require at their London Headquarters DRAUGHTSMEN to assist in design work associated with the introduction of advanced manufacturing and data processing techniques. Applicants, who should be between the ages of 25 and 35, must have had at least three years' experience in the electronic or light engineering industry and must have O.N.C. or equivalent qualifications.—Applications, giving details of training, qualifications and experience, should be addressed to Head Office, Staff Department (WF 43), Unilever House, Blackfriars, London, E.C.4. E7244 A

U.S.A.: SETTERS, FITTERS, TOOL DIE MAKERS/SETTERS, &c., wanted. High salaries, fares advanced. 15s. to 18s. an hour upward, plus bonus.—Write details of experience to Maida Vale Bureau, 444, Edgware Road, W.2. (Tel.: Willesden 3857.) E2515 A

WADKIN LIMITED OF LEICESTER (Manufacturers of Woodworking Machinery and High Speed Machine Tools) require a young man as ASSISTANT TO WORKS DIRECTOR. Applicants (age 28/35) with first-class technical and general education should possess a good experience of modern machine shop practice and production methods, preferably in the machine tool industry. They should also possess initiative, drive and personality and be capable of day-to-day management of a works employing 600 workpeople. The post offers a good commencing salary with excellent prospects and a contributory pension scheme is in operation.—Applications, which will be treated in the strictest confidence, giving details of experience and salary required, should be addressed to the Works Director, Wadkin Limited, Green Lane Works, Leicester. E7235 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WELL-ESTABLISHED COMPANY in Foundry Plant Trade desires the services of an experienced man to take over management. Excellent prospects, or amalgamation considered. Replies treated in confidence.—BOX No. E2529, "The Engineer." A

SENIOR PRODUCTION ENGINEER

for a progressive and expanding firm of light engineers near Manchester, employing some 700 people. Commencing salary about £2000 p.a. Preferred age 38–45.

This new appointment, which has resulted from the growth of the Company, will be nominally responsible to the Production Manager and offers considerable scope for the future. Initial duties will be to study the Company's products and manufacturing methods and to put forward recommendations for improving production planning and control (including especially machine-loading), materials control and progress. Thereafter the Senior Production Engineer will be in full charge of these functions and will also be responsible for developing and maintaining close liaison with works management, jig and tool design, inspection, etc.

Essential qualifications are sound knowledge and experience of light engineering working to normal tolerances and of modern control techniques as applied to batch production. Must also have a down-to-earth and flexible mind with the ability to control staff. A.M.I.Mech.E. or A.M.I. Prod.E. preferred, but H.N.C. would be acceptable if accompanied by extensive practical experience.

Please write briefly in first instance, quoting Reference No. 203, to :—

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1
retained to advise on this appointment

The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

E7240 A

BOOKS and PUBLICATIONS

PITMAN
TECHNICAL
BOOKS

FROM ALL BOOKSELLERS

Parker St., Kingsway,
London, W.C.2.

FACTORY ADMINISTRATION IN PRACTICE

By W. J. Hiscox and James Stirling. A.M.I.Mech.E. 7th Edition. Here is a new edition of a book that is so excellent that it has been adopted as a class textbook for students of industrial organisation in educational institutions throughout the country. Recommended also by the Institute of Cost and Works Accountants. 18/– net.

MODERN ELECTRONIC COMPONENTS

By G. W. A. Dummer, M.B.E., M.I.E.E., etc. The first comprehensive book of its kind to be published in the world. It presents a comprehensive survey of the characteristics of the more common components, together with information on their behaviour under the arduous environmental conditions to which they are now frequently subjected. 55/– net.

SOLUTION OF PROBLEMS IN THEORY OF MACHINES

By S. Anvoner, B.Sc., etc. This new book contains 488 examples, of which 203 are fully worked out and the remainder left as exercises for which answers are provided. Most of the examples are taken from past examination papers in B.Sc. (Eng.), London, carefully chosen to cover a wide range of topics. 35/– net.

ANALYSIS OF PIPE STRUCTURES FOR FLEXIBILITY

By John Gascoyne, A.F.Inst.Pet. A new book for piping designers and designer-draughtsmen which deals with specialised piping design for high-temperature and high-pressure use where the ordinary procedures do not apply. 45/– net.

HELICOPTER DYNAMICS AND AERODYNAMICS

By P. R. Payne. This is the first really comprehensive treatment of helicopter theory by a practising designer of rotary wing aircraft. The book which is more up to date than anything yet published on the subject, contains the first accounts in book form of cantilever, stiff-hinged, high flapping pin offset and other advanced forms of rotor, and also the rotor blade flutter. 84/– net.

"A complete library in two volumes.."

KEMPE'S

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1959 (64th Edition)

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★ **3,000 pages covering modern theory and practice in all branches of engineering. No other single publication devoted to engineering covers a comparable range of subjects so concisely.**

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CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH AND DEVELOPMENT DEPARTMENT

Applications are invited for the following appointments in the research team located at Littlebrook Power Station, Dartford, Kent.

The team is developing an advanced steam cycle for power generation employing steam at 1400 deg. Fah. as the working fluid for a "gas" turbine as proposed by J. F. Field (Proceedings, I.Mech.E., V.162, P.209, 1950, refer). A portion of the steam is bled from the "gas" turbine circuit and passed through a condensing turbine before re-entry into the primary circuit. The cycle, which contains many unorthodox features and presents many exciting problems, could conceivably be operated with coal, oil or nuclear fuel and provides an opportunity to gain experience in many aspects of power generation.

A superheater with steam capacity of 100 k.lb. per hour is nearing completion and a 15MW pilot plant is planned.

MECHANICAL ENGINEER

The mechanical engineer should be capable of directing a team working on steam cycle analysis and thermodynamic studies relating to both the superheater and the pilot plant.

Candidates should preferably hold a good honours degree with several years' experience with steam plant and have a lively interest in thermodynamics and the theoretical aspects of steam engineering.

The salary will be on a scale within the range £1590–£2045 p.a., according to duties and responsibilities.

ENGINEERS, PHYSICISTS, MATHEMATICIANS

A programme of both theoretical and experimental work is envisaged and successful candidate will assist in running the experimental steam superheater and in the design and subsequent operation of 15MW pilot generating plant mentioned above. They will also be required to study problems involving one or more of the following :—

The thermodynamics and aerodynamics of steam and gas turbines and axial flow compressors, radiant and convective heat transfer, combustion technology associated with P.F. and oil firing, corrosion resistance and high temperature metallurgy.

Candidates should preferably have an honours degree, with a strong inclination for research and development work.

Salaries will be on scales within a range rising to £1350 p.a., according to duties and responsibilities. Promotion prospects are good in an expanding organisation.

Applications stating age, qualifications, experience, present position and salary should be forwarded to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 19th September. Envelopes should be marked "Confidential Ref. ENR/347."

Candidates who are interested and would like to have further preliminary information about these posts are invited to telephone CHAncery 2866, Ext. 134.

E7206 A

Classified Advts. continued on page 148

SITUATIONS VACANT

PERU

An important American organisation urgently require the following personnel for their SUGAR ESTATES and PAPER MILL located in PERU :

TWO INDUSTRIAL ENGINEERS for the SUGAR ESTATES. Applicants for these positions should have a good academic background, plus several years of working experience, not necessarily in the sugar industry. They should be able to work independently and show initiative not only in the planning and carrying out of assigned projects, but also in originating projects and ideas of their own. Some immediate assignments would be : manpower surveys, including manning standards for the various operations, as well as operational studies with new machinery, and efficiency studies in the factories.

ONE INDUSTRIAL ENGINEER for the PAPER MILL, who, in addition to the requirements outlined above, should be conversant with the various ramifications of the paper production process, including pulping operations, paper production, conversion of paper into its various by-products and be familiar with plant organisation and structure.

Candidates for all three vacancies should be between 25 and 40 years of age. Housing will be provided on Company property (bachelor quarters if single). Educational facilities are available for children up to nine years old. Home leave of three months every two years nine months is provided, with passages paid for the employees and their families. Salaries are paid partly in U.S. dollars and partly in Peruvian pesos.

Please apply in strict confidence with full details to : Managing Director, Grace Brothers, Ltd., 143/9, Fenchurch Street, London, E.C.3.

E7255 A

CENTRAL ELECTRICITY GENERATING BOARD

DESIGN AND CONSTRUCTION DEPARTMENT

NUCLEAR PLANT DESIGN BRANCH. Ref: ENR/350

The Branch is responsible for the design and layout of the Reactor Units in the Board's Nuclear Power Stations. It works closely with the U.K.A.E.A., the Industry and the Board's Project, Research and Operations Groups.

The Branch is organised on a functional basis and responsibility is given within the following sections :

Reactor Core
Reactor Mechanisms (including Fuel Handling)
Pressure Circuit (including Boilers and Gas Circulators)
Reactor Materials
Layout (including Shielding and Health Physics)
Control and Instrumentation
Performance

Applications will be welcomed for positions as **SENIOR ASSISTANT ENGINEERS** from men or women (who are interested in any of these fields) whose training and experience, based on sound academic qualifications in any branch of engineering, science, or mathematics would justify consideration.

The range of specialisation is not rigid and candidates are asked to state their interests and to write in sufficient detail, including age, qualifications, experience and present salary, to enable a preliminary assessment to be made.

The work is based at the Board's Headquarters in London, but will involve visits to sites, to U.K.A.E.A. Establishments and to Contractors' Offices and Works.

Training will be given where necessary.

Salaries will be on scales within the range £1475–£2045 p.a. according to duties and responsibilities. Unsuccessful candidates will be considered for less senior posts on scales within the range £900–£1605 p.a. unless a request is made to the contrary.

OPERATIONS DEPARTMENT

NUCLEAR OPERATIONS BRANCH

at HEADQUARTERS, LONDON, S.E.1.

ASSISTANT ENGINEERS Ref: ENR/348

Successful candidates will be concerned with co-ordinating with the Operating Regions, the commissioning, operation and maintenance of the Board's nuclear power stations, the technical assessment of operating results and performance investigations.

The Nuclear Operations Branch is also concerned with design liaison, staffing and training for nuclear power stations, fuel cycles and liaison with the Nuclear Health and Safety Department.

Candidates should have an engineering degree or equivalent qualification and should have practical experience in the commissioning, operation and maintenance of power stations or similar plant.

Salaries will be on scales within the range £1245 p.a.–£2045 p.a., according to duties and responsibilities.

Applications stating, age, qualifications, experience, present position and salary should be forwarded to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 22nd September. Envelopes should be marked "Confidential," quoting relevant reference number.

E7241 A

PIPING/ANALYTICAL ENGINEERS

Chemical or Mechanical Engineers are required for work on the design of process and utility piping systems for oil refinery and petro-chemical plant. The work involves the preparation of engineering flow diagrams and close liaison with our Process, Instrument, Mechanical Equipment, Plant Layout and Operating groups.

Applicants should have a University Degree in either Chemical or Mechanical Engineering and also at least two years' relevant post-graduate experience in industry.

A formal training programme is arranged for new employees. Above average salaries will be paid to men with the required qualifications. Personnel benefits include contributory Pension Scheme, Luncheon Vouchers, Social Club, etc. When overtime is worked, payment is made for hours involved. Holiday commitments for this year will be honoured.

Apply by letter to Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION

7–10 CHANDOS ST., CAVENDISH SQ., LONDON, W.1

(Please quote reference 149/G.)

E7242 A

SITUATIONS VACANT

NORRIS CONSULTANTS LTD.,

in view of a two-year expansion programme, require for their London and Bristol Offices and elsewhere in the U.K., Senior and Junior Engineers, Designers and Draughtsmen in the following fields.

CIVIL ENGINEERING DIVISION

Reinforced Concrete, Heating, Ventilating, Air Conditioning, Refrigeration, Pipework and General Services, Structural Steelwork.

PRODUCTION & MECHANICAL DIVISION

Special purpose machines, Transfer Systems, Jigs and Tools, General mechanical, Mechanical Handling, Electrical (Heavy and Light current).

Salary scales up to high level in accordance with age, experience, technical and professional qualifications. Pension and Insurance schemes. Write or telephone Head Office, Beacon House, Queens Road, Clifton, Bristol. Tel. : Bristol 3-6817, or those requiring appointments in London Area, write or telephone : 76, Victoria Street, S.W.1. Tel. : VIC 4675.

E7020 A

SENIOR ENGINEERING ASSISTANTS

Northern Rhodesia

A large copper mine in Northern Rhodesia requires SENIOR ENGINEERING ASSISTANTS (MECHANICAL and ELECTRICAL), preferably aged 27 to 33 years.

Applicants should have a degree in Electrical or Mechanical Engineering, or equivalent qualification, and should have had previous experience in heavy engineering. Initially, the duties will consist of assisting with the planning of engineering projects of a varied nature in connection with large-scale copper mining operations, including power generation and distribution, mine shafts and haulages, ore treatment, smelting, and other associated heavy engineering plant. From time to time opportunities for promotion arise for suitable men.

The initial basic salary would be not less than £1350 per annum, plus a cost-of-living allowance currently £65 per annum. In addition there is a variable bonus which for the year ended 30th June, 1959, was 36 per cent of basic salary. The successful candidate will be required to join the Company's Pension and Life Assurance Scheme ; employee contributions are a minimum of 5 per cent of basic earnings but may voluntarily be increased to 15 per cent. The Company contributes 5 per cent plus ½ per cent for each completed year of service.

The employee's outward passage is paid by the Company.

Leave is at the rate of 51 days per annum and may be accumulated up to 153 days.

Married accommodation is available on engagement at sub-economic rental.

Applications giving full particulars of age, qualifications and experience should be sent to :

Mine Employment Department,
Selection Trust Limited,
Mason's Avenue, Coleman Street, London, E.C.2.

Please quote R.21 E.

E7223 A

UNILEVER

have vacancies for

ELECTRONIC ENGINEERS

AT THEIR LONDON HEADQUARTERS

Selected candidates will be required to assist in the design, construction, installation, and operation of equipment for applying the most advanced automation techniques to manufacturing processes and office systems.

Applications are invited from engineers between the ages of 25 and 35 having a degree in science or engineering or an equivalent qualification. A recognised apprenticeship or at least three years' industrial experience is desirable.

Applications, giving details of training qualifications and experience, should be addressed to Head Office Staff Department (WF 42), Unilever House, Blackfriars, London, E.C. 4.

E7217 A

SITUATIONS VACANT

BRITISH RAILWAYS
(Southern Region)
require an
ELECTRICAL ENGINEER
at VICTORIA

with knowledge of Docks and Marine Mechanical and Electrical Engineering practice.

Applicants should preferably have served an approved apprenticeship and possess a Higher National Certificate in Electrical Engineering. Drawing-office experience essential.

Commencing salary £943 p.a.

Travel concessions. Superannuation scheme.

Applications, giving full details of education, training, technical qualifications and experience, to Shipping and Continental Manager, British Railways (Southern Region), Victoria Station, London, S.W.1, quoting reference SC/SAS/3188.

E7207 A

RESEARCH ENGINEER

MECHANICAL ENGINEERS are required by COURTAULDS, LIMITED, for its Research and Development Organisation in Coventry to work on a wide variety of process development and pilot plant operations. Applicants should possess a First or Second Class Honours Degree in Engineering, be not more than 28 years of age, and have had not less than 2 years' industrial experience.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Ltd., 16, St. Martin's-le-Grand, London, E.C.1, quoting reference number D.93. E7198 A

WORK STUDY ENGINEER

A major Engineering Company of international repute and in the lead in its product fields, intends to widen the scope of application of measured work in certain of its plants. In consequence, it wishes to appoint a well-qualified and experienced Work Study Engineer at its largest establishment, bordering on the Home Counties, to be responsible for the application of modern incentive techniques to a number of new production lines. The vacancy will provide a challenge to a first-rate engineer with substantial study experience of metal fabrication in flow production. Salary will be commensurate with experience and the post offers considerable opportunity for promotion.

Applications with full curriculum vitæ including details of salaries earned, may be made in strict confidence to BOX No. 2807, c/o Charles Barker & Sons, Ltd., Gateway House, London, E.C.4.

E7229 A

ASSISTANT DESIGN ENGINEERS

are required for design investigation and the preparation of design layouts and schemes, following the work through its various stages, in connection with a large proton synchrotron being built at Harwell for the NATIONAL INSTITUTE for RESEARCH in NUCLEAR SCIENCE.

Applicants should have served a recognised engineering apprenticeship or had equivalent training and should have H.N.C., graduateship of a senior engineering institution or equivalent qualifications. They should have design office experience of : (a) chemical plant, pipe work or similar work ; (b) general mechanical engineering, particularly vacuum techniques (some basic electrical knowledge required), or (c) electrical control systems and light current electrical equipment (some electronics knowledge an advantage).

Salary : £910–£1315. Housing assistance and superannuation. Please send a POST CARD for details to the Group Recruitment Officer (5044/25), U.K.A.E.A., A.E.R.E., Harwell, Berks.

E7205 A

SITUATIONS WANTED

CHARTERED MECHANICAL ENGINEER seeks appointment requiring original thought. In addition to executive duties experience includes design and development both in this country and on the Continent.—BOX No. E2526, "The Engineer." B

MISCELLANEOUS

MOBILE LIFTING SERVICES.—Lump Sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E7215 I

AGENCIES

MANUFACTURERS seeking to increase their sales in Scotland may secure reliable agents by writing with particulars to the Secretaries of the Scottish Association of Manufacturers' Agents, who will advertise under a box number in the Association News Letter.—Write to Dept. E, Hourston MacFarlane and Co., 5, St. Vincent Place, Glasgow, C.1. E148 D

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 O

ADVERTISER, PRIVATE INVESTOR desires to purchase whole or part interest in concern under progressive management making annual net profit of £15/50,000.—BOX No. E163, "The Engineer." O

TO ENGINEERING GROUPS.—Ultra Modern Foundry producing HIGH-GRADE GREY IRON CASTINGS, capacity 200 tons weekly. Would consider amalgamation and/or co-operation. Asset value of freeholds and plant approximately £150,000/£200,000.—BOX No. E165, "The Engineer." O

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

CENTRE LATHES :
Up to 14ft. 0in. dia. by 44ft. 0in. long.
VERTICAL BORING :
Up to 15ft. 7in. dia. by 8ft. 0in. high.
HORIZONTAL BORING :
Up to 8in. spindle, 40ft. 0in. by 20ft. 0in. table.
PLANING :
Up to 34ft. 0in. long by 11ft. 11in. wide by 8ft. 0in. high.
PLANO MILL :
Up to 14ft. 0in. long by 6ft. 6in. wide by 5ft. 6in. high.
SHAFT GRINDING :
Up to 23ft. 0in. long by 2ft. 0in. dia.
SLIDEWAY GRINDING :
Up to 7ft. 0in. long by 4ft. 0in. high by 2ft. 0in. wide.
VERTICAL SPINDLE GRINDING :
Up to 11ft. 0in. long by 1ft. 9in. high by 2ft. 0in. wide.

HARVEY

G. A. HARVEY & CO. (LONDON) LTD., WOOLWICH ROAD, LONDON, S.E.7.

E7256 MW

PATENTS

THE PROPRIETOR of British Patent Nos. 711298, 711299 and 709958, entitled "Improved Plug Closures For Handholes and the Like of Pressure Vessels," "A Gate Valve With an Improved Bonnet and Sealing Means Therefor," and "Improved Plug Closures For Hand and Like Holes in Pressure Vessels," respectively, offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E. Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E7203 H

THE PROPRIETOR of British Patent No. 751550, entitled "IMPROVED PILOT BIT FOR AN EARTH BORING AUGER," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E. Jackson Blvd., Chicago 4, Illinois, U.S.A. E7237 H

THE PROPRIETOR of British Patent No. 709968, entitled "LASHING MACHINE FOR AERIAL CABLES," offers same for Licence or otherwise, to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14 E. Jackson Blvd., Chicago, 4, Illinois, U.S.A. E7236 H

THE PROPRIETOR of British Patents Nos. 711112 and 751139, entitled "IMPROVEMENTS RELATING TO THE CONDITIONING OF THE EXHAUST GASES OF INTERNAL COMBUSTION ENGINES" and "EXHAUST GAS PURIFIER," offers same for License or otherwise, to ensure practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, 14 E. Jackson Blvd., Chicago, 4, Illinois, U.S.A. E7252 H

FOR HIRE

BELLMANS MASTS FOR HIRE, to lift from 1 to 20 tons, 30ft. to 150ft. Blocks and tackle. Hand-operated winches. From £1 per day.—BELLMAN'S (Phone : SLOane 5259), Hobart House, Grosvenor Place, S.W.1. E103 K

MACHINERY Etc. WANTED

WANTED, MASSON SCOTT ROTARY CUTTER, either 12 by 24 or 18 by 36. Full details, BOX No. E7247, "The Engineer." F

FOR SALE

RICKMANSWORTH AND UXBRIDGE VALLEY WATER COMPANY

REDUNDANT PLANT FOR DISPOSAL

Offers are invited for the undermentioned redundant PLANT which the Company has for DISPOSAL :—

(1) ONE LANCASHIRE BOILER, 7ft. 6in. by 30ft., with superheater. 150 lb. pressure, by H. and T. Danks, 1930 ; also Bennis Stoker and Airdraught Furnace.
(2) ONE DITTO, 8ft. by 30ft., with superheater. 150 lb. pressure, by Edwin Danks, 1933, with Bennis Stoker and Airdraught Furnace.
(3) TWO STEAM BOILER FEED PUMPS and WATER TREATMENT PLANT.
(4) BELLISS and MORCOM TRIPLE EXPANSION STEAM ENGINE coupled 180kW., 220V., D.C. Generator and Condensing Plant.
(5) BROWETT LINDLEY 300 B.H.P. COMPOUND VERTICAL STEAM ENGINE and CONDENSING PLANT.
(6) BELLISS and MORCOM COMPOUND STEAM ENGINE, 200 B.H.P., 380 R.P.M., with Condenser and "V" drive Pulley.
(7) D.C. VOLTAGE BOOSTER, 50 B.H.P., 500A. by 65V. by 230V. input.
(8) GREENWOOD and BATLEY STEAM TURBINE and Gearing, 150 B.H.P. at 1500 R.P.M., with Atmospheric Condenser.
(9) BELLISS and MORCOM STEAM TURBINE GENERATING SET, 500kW., 220V., D.C., with condensing plant. Excellent condition.

The plant may be inspected by appointment being made with the Chief Engineer at the Head Office of the Company, Batchworth, Rickmansworth, Herts. Telephone No.: Rickmansworth 3122. E7266 G

HYDRAULIC FORMING AND FORGING PRESSES

3000-ton Down-stroke PRESS for HEAVY PLATE FORMING AND BENDING, rams ; admitting 10ft. 6in. between columns ; bed 16ft by 8ft..
2000-ton Down-stroke FORGING PRESS, 5ft. stroke ; bed 8ft. 6in. by 8ft. ; daylight 11ft.
1000-ton Down-stroke FORGING PRESS by Wellman, bed 7ft. by 6ft. ; daylight 9ft.
475-ton FLANGING PRESS by Hugh Smith, table 10ft. dia., 4 vice rams.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone : Woolwich 7611/6.
E7184 G

RICHARDS NO. 2 HORIZONTAL BORING AND FACING MACHINE. Model PRT 2N, 3in. traversing spindle. Facing head to face up to 30in. diameter. Screw cutting by change gears. Main table 4ft. by 2ft. 6in. Revolving table 3ft. by 3ft. Facing head to end stay 6ft. 6in. Spindle centre to top table 2ft. maximum. Verniers fitted to head, end stay and table. V-belt drive from 10 h.p. Motor 400/3/50. H. BELL (MACHINE TOOLS), LTD., WALTER STREET, LEEDS, 4. Tel. : 63-7398. E105 G

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia. 100/150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p., 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry mounted 30ft.–70ft. extendible jib ; 10-ton 33 R.B. track mounted, 40ft. jib ; 8½-ton Ransomes Diesel/Electric, 21ft. jib ; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2) ; 6-ton Coles Diesel/Electric, solids ; 4-ton Coles Diesel/Electric, solids ; 1945 ; 4-ton Jones KL44, diesel, 1950 ; 3-ton Jones "Super 40" diesel, pneumatics (3).

OVERHEAD CRANES.—40-ton Babcock, 40ft. span, 400/3/50, "Goliath" ; 30/5-ton Adamson, 42ft. 3in. span, 400/3/50 ; 20/6-ton Vaughan, 42ft. 3in. span, cab type (6) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; 15-ton Morris, 35ft. span, hand-operated ; 10-ton Morris, 45ft. span, 36ft. lift ; 10-ton Morris "Goliath," 40ft. span, 400/3/50 ; 10-ton Vaughan, 23ft. 6in. span, 400/3/50 ; 10-ton Vaughan, 21ft. span, 44ft. lift, 7½ tons ; Wharton, 25ft. span, 400/3/50 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton Morris, 58ft. span, hand-operated ; 5-ton Royce, 2-motor crab, 440/3/50 ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V, d.c. (3) ; 3-ton Adamson, 48ft. span, 400/3/50 ; 2-ton Adamson, 34ft. span, 400/3/50 (2) ; 2-ton Morris, 18ft. span ; 2-ton Vaughan, 27ft. 6in. span, 2-motor ; majority of the above are unused.

DERRICK CRANES.—7-ton Rushworth, hand, 30ft. jib ; 5-ton Wilson, Electric, 70ft. jib ; 5-ton Butters, hand, 45ft. jib ; 1½-ton Anderson Grice, hand, 40ft. jib.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib ; 10-ton Coles, steam, 40ft. jib ; 10-ton Grafton, 34ft. jib, diesel conversion ; 8-ton Wilson, steam, 35ft. jib ; 5-ton Grafton, 35ft. jib, diesel conversion ; 5-ton Smith, 50ft. jib (2) ; 5-ton Cowans Sheldon, 50ft. jib.

LOCOS.—Fowler diesel, 150 h.p. (2) ; Ruston diesel, 80/88 h.p., new 1942 ; Bagnall 14in. by 22in., two oil-fired, one coal ; Peckett, steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft. 3in. black, new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot. New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¾in. ; Robertson Straightening Rolls, 8ft. 6in. by ¾in. ; Berry Bending Rolls, 7ft. by ¼in. ; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table ; Herbert 3ND Miller, 61in. by 15in. table ; Pels Punch and Shears, ¾in. capacity ; nine new 2 cwt. and 1 cwt. Pneumatic Hammers ; Bliss 14T Tapering Press ; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore ; 100-ton Bigwood geared Bending and Straightening Machine up to 12in. by 6in. R.S. Joists ; two 40kVA Spot Welding Machines ; Wire Drawing Machine, 3 die up to ¾in. copper ; 50kW Electric Furnace 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone : Coleford 2271/2. E106 G

FOR SALE

LANG 15in. centre by 23ft.
GAP BED LATHE ;
admit 16ft. between centres ; swing 47in. by 12in. in gap.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD,
LONDON, N.W.1.
EUSton 4681 and 3771.
E7211 G

FOR SALE.—40 TONS UNUSED STEEL FLATS, 2½in. by ¾in. by 16ft. Price £28 per ton delivered. Inspection at Manchester. Samples on request.
Further details :—
COX AND DANKS,
FREDERICK STREET, SALFORD, 6.
E7263 G

Classified Advts. continued on page 150

FOR SALE

WARRAGAMBA DAM

CONSTRUCTION PLANT

To be sold by the

SYDNEY WATER BOARD, N.S.W., AUSTRALIA

The construction of Warragamba Dam, containing 1,600,000 cu. yds. of concrete, is approaching completion. The Special Plant used for excavation, winning, processing, transporting, storage and delivery of concrete aggregates, and batching, mixing, placing and cooling of the concrete will become progressively available for sale over the next two years, and will be offered for purchase by Public Tender. An illustrated brochure will be forwarded upon request to prospective buyers.

Public Tender Documents which are expected to be available for issue of items 1, 2 and 5 on 2nd November, 1959, and for items 3, 4 and 6-9 on 3rd February, 1960, will be forwarded on request. Tenders will remain open for 3 months and are to be enclosed in envelopes endorsed "Warragamba Dam Plant Item No. . . . ." and addressed to the Secretary, M.W.S. & D. Board, 341 Pitt Street, Sydney.

Item 1. AGGREGATE WINNING AND PROCESSING PLANT—Capacity 400 tons/hr., 5 cu. yd. Dragline Excavator, Heavy Duty off-highway Type Dump Trucks, Tournadozers, Conveyors, Vibrating Screens, Crushers, Radial Stackers, Vibratory Feeders, Sand Washers, Pumps, Dewaterers, Sand Sizing and Classifying Plant. (Available approx. February, 1960.)

2. BI-CABLE AERIAL ROPEWAY—150 tons per hour capacity, length 12.3 miles, automatic loading and unloading stations, 4 driving stations, 2 angle stations, 7 other cable track divide stations, 200 steel support trestles, 10 road crossing protection bridges, 600 carriages and buckets of 31 cu. ft. capacity. (Available approx. February, 1960.)

3. TWO 18-TON CAPACITY ELECTRIC CABLEWAYS—One fixed steel head tower and two travelling steel tail towers. Cable spans 1,640 and 1,795 ft. Outstanding features include "Ward Leonard" drives providing regeneration of power, rheostatic speed controls and comprehensive safety devices. (Available not before early 1961.)

4. ONE 10-TON ELECTRIC CABLEWAY—Travelling head tower and fixed tail tower, cable span 1,033 ft. Features are rheostatic speed control and dynamic braking. (Available not before September, 1960.)

5. CRUSHED ICE PLANT—Capacity 160 tons per day of clear ice; 3 "Vogt" tube-ice machines, 4 condensers and 5 "Budge" Compressors. (Available approx. March, 1960.)

6. REFRIGERATION PLANT FOR COOLING WATER—Capacity 1,400 g.p.m. of water from 50°F. to 42°F., 4 "Werner" Compressors, 4 Condensers, 4 multipass Water-Coolers and 4 Pumps. (Available not before June, 1960.)

7. AUTOMATIC CONCRETE BATCHING AND MIXING PLANT—Capacity 150 cu. yds. hour; steel tower, bins, 9 "Johnson" automatic weigh batchers and 4/2 cu. yds. tilting drum "Koehring" Mixers. (Available not before June, 1960.)

8. PNEUMATIC BULK CEMENT HANDLING AND STORAGE PLANT—Two "Fuller Kenyon" Cement Pumps (45 tons/hour each); 2 Silos and 2 Bins (total capacity 2,000 tons) and approx. 20 Transport Hoppers (3 tons each). (Available not before September, 1960.)

9. CONCRETE HANDLING EQUIPMENT—"Planet" diesel locomotive; 6 rail trucks and 11 "Johnson" double clam shell, air-operated concrete buckets of 8 and 4 cu. yd. capacity. (Available not before June, 1960.)

A. R. STAFFORD, Secretary,
M.W.S. & D. Board, 341 Pitt Street, Sydney, N.S.W., Australia

E 7222

MW184-59

FOR SALE

Edwards

BIGWOOD Type FBC, 4-Roll, Motorised Plate Bending and Straightening Machine, three rollers set pyramid fashion for bending and additional fourth roller for flattening, arranged motor drive 440/3/50, capacity 4ft by ¾in., length of rolls 53¼in. Weight approximately 90 cwt.

SCRIVEN Geared 7-Roll Plate Straightening Machine, capacity ⅝in. thick, size of rollers 74in. long by 6½in. diameter, arranged motor drive 400/3/50, rolls arranged 5 on top and 4 on bottom alternate fashion. Weight approx. 5 tons.

NEW BESCO 8ft. 4in. by ⅜in. Type HK, All-Steel Undercrank, Open-End Production Power Guillotine of steel construction, arranged motor drive, automatic hold-down, adjustable front and back gauges.

SCHULER Power-Geared Open Fronted, Inclinable, Cam-Action, Double-Action Drawing Press, with adjustable bed, spring-balanced blankholder, with automatic ejector and vertical adjustment, punch stroke 11in., blankholder stroke 4¾in., bed 24¾in. by 14¾in.

CRAIG and DONALD Model 400/10 All-Steel, Motorised, Double-Geared Press Brake of steel plate construction, pressure exerted 400 tons, forming capacity 10ft. by ¼in., depth of gap 12in., width between side frames 82in., stroke 4in., maximum daylight, stroke down adjustment up, 18in., arranged motor drive 440/3/50, air-operated treadle clutch. Weight about 29 tons.

NEW STOELTING Pyramid Type Plate Bending Roller, motorised 400/440/3/50, capacity 10ft. wide by ¼in. mild steel, diameter of rollers, top 9¼in., bottom 7⅛in., drop-end bearing for removal of completed cylinders, support rollers to bottom rolls, reduction gearbox drive to bottom rolls, with multi-disc slipping clutches, motorised adjustment to top roller.

Photographs of the above are available.

Very favourable Hire Purchase terms can be obtained.

MACHINE TOOLS, NEW AND USED.
Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,

359–361, EUSTON ROAD,
LONDON, N.W.1.
Telephone : EUSton 4681–3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone : Central 7606–8. E207 G

TRANSPORTABLE HEAVY DUTY OXYGEN CUTTER MODEL DMC.50, complete with Powder Dispenser. Capable of cutting through steel 4ft. thick. Absolutely new condition. Inspection and offers invited.—Clugston Cawood, Ltd., St. Vincent House, Normanby Road, Scunthorpe. Tel. 4521. E2524 G

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

Fielding 500-ton Vertical Downstroke Hydraulic Press, 42in. by 36in. platens, with pumps and motors.
Fielding 200-ton, ditto, 3ft. stroke, with pumps and motors (5 available).
Fielding 100-ton ditto, 4ft. to 5ft. stroke, with pumps and motors.
Two 73ft. 4in. by 5ft. Kilns or Dryers, with Crofts Reduction Gear and 27 h.p. motor.
Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.
Available at low prices ex present sites to save cost of bringing into stock.

FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. E151 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft., and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel. : Bexleyheath 305). E113 G

YOU'RE ON YOUR TOES when you *remember* WARDS *might have it!*

THOS. W. WARD LTD
ALBION WORKS, SHEFFIELD

FORGED STEEL PIPE FITTINGS

Screwed A.P.I., B.S.T.P.T. or socket weld. Materials: Carbon steel, chrome molybdenum or stainless steel.

C.W.P. non-shock
2000 lbs series
3000 lbs series
6000 lbs series

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September 15–16	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
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September 29–30	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sale at Cheetham Town Hall, Cheetham, Manchester, 8.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
October 2	Miscellaneous stores.	Returned Stores Group, Reed Hall, Colchester, Essex.	FENN, WRIGHT & CO. (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
October 7	Vehicles and miscellaneous stores.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)

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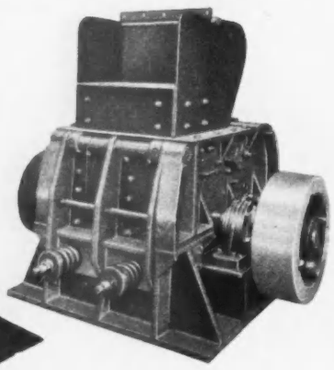

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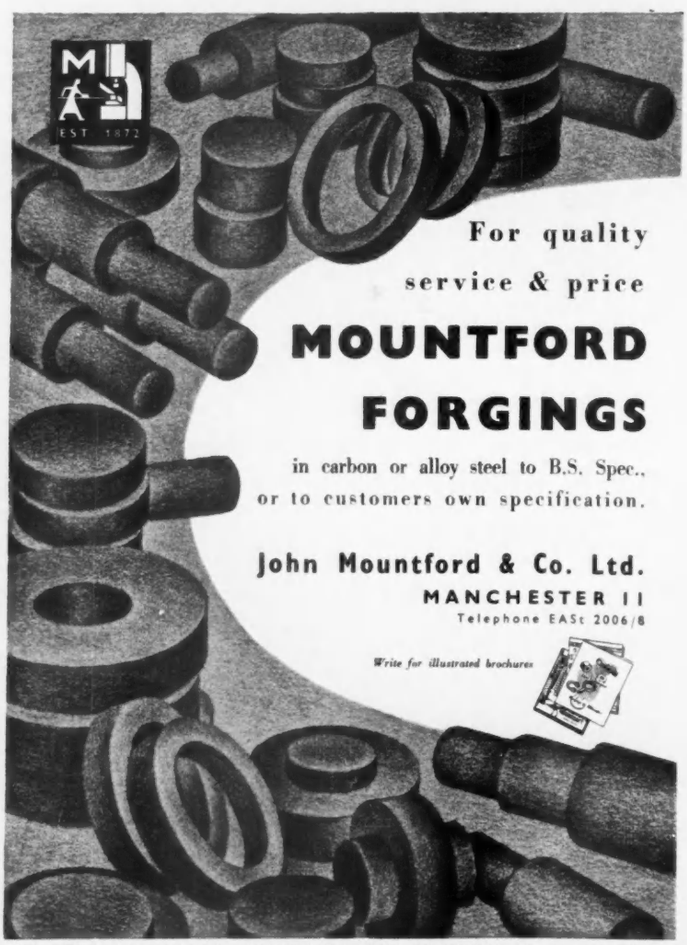

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INDEX TO ADVERTISERS

PAGE

Abbot Engineering Co., Ltd. 86
Aero Maintenance Equipment, Ltd. 55
Air Industrial Developments, Ltd. 126
Albright & Wilson (Mfg.), Ltd. 49
Allday, W., & Co., Ltd. 41
Allen, W. G., & Sons (Tipton), Ltd. 83
Allott Bros. & Leigh, Ltd. 88
Ames Crosta Mills & Co., Ltd. 79
Anderson-Grice Co., Ltd. 98
Anderton Springs, Ltd. 119
Andre Rubber Co., Ltd. 135
Arrol, Sir William, & Co., Ltd. 92-93
Associated Electrical Industries, Ltd. 154
Atcost, Ltd. 13
Austinlite, Ltd. 71
Autohall 111
Autometric Pumps, Ltd. 72
Automotive Products Co., Ltd. 85
Avery, W. & T., Ltd. 109

B.T.R. Industries, Ltd. 119
B.R.C. Engineering Co. 137
Babcock & Wilcox, Ltd. 9
Baker, W. A., & Co., Ltd. 139
Barnet Metal Co., Ltd. 121
Barr Thomson & Co., Ltd. 79
Barron, W. S., & Son, Ltd. 133
Belmos Co., Ltd. 105
Beresford, J., & Son, Ltd. 139
Birfield Industries, Ltd. 136
Birkett, T. M., Billington & Newton, Ltd. 100
Birmingham & Blackburn Construction Co., Ltd. 99
Blakeborough, J., & Sons, Ltd. 127
Boilerine, Ltd. 88
Booth, J., & Bros. 24
Boulton Paul Aircraft, Ltd. 129
Braby, F., & Co., Ltd. 78
Brackett, F. W., & Co., Ltd. 126
Brady, G., & Co., Ltd. 122
Braithwaite & Co., Engineers, Ltd. 68
Bridges, G. F., Ltd. 77
Britannia Iron & Steel Works, Ltd. 132
British Aero Components, Ltd. 64
British Aluminium Co., Ltd. 47
British & General Tube Co., Ltd. 99
British Jeffrey-Diamond, Ltd. 152
British Paints, Ltd. 99
British Rolling Mills, Ltd. 45

PAGE

Broadbent & Co. (Rochdale), Ltd. 85
Broom & Wade, Ltd. 52
Brotherhood, P., Ltd. 67
Brown, D. (Brownall), Ltd. 76
Brown, E. G., & Co., Ltd. 15
Brown, Lenox & Co. (London), Ltd. 141
Brown, R. (Espedair Foundries), Ltd. 108
Brown & Tawse Tubes, Ltd. 70
Brownlie & Murray, Ltd. 72
Buckau, R. Wolf 57
Bullers, Ltd. 123
Bullows, A., & Sons, Ltd. 152
Burgess Products Co., Ltd. 134
Burtonwood Engineering Co., Ltd. 54
Bury Felt Manufacturing Co., Ltd. 3
Butcher, H., & Co. 151

C. & M. Engineering Co., Ltd. 121
Cascade Water Coolers, Ltd. 18
Clark, G., & Sons (Hull), Ltd. 110
Clarkson (Engineers), Ltd. 61
Clyde Blowers, Ltd. 15
Clyde Crane & Booth, Ltd. 24
Clyde Crane & Engineering Co. 24
Clydeside Machine Tool Co., Ltd. 98
Cockburns, Ltd. 106
Cohen, G., Sons & Co., Ltd. 140
Consett Iron Co., Ltd. 71
Conveyor & Elevator Co. (1936), Ltd. 18
Cory Brothers & Co., Ltd. 58
Crofts (Engineers), Ltd. 32-33
Cross Manufacturing Co. (1938), Ltd. 131
Crowthorn Engineering Co., Ltd. 131

Datim Machine Tool Co., Ltd. 86
Delta Metal Co., Ltd. 61
Dilloway, P. W., Ltd. 103
Distington Engineering Co., Ltd. 44
Dorman Long (Steel), Ltd. 76
Douglas, Lawson & Co., Ltd. 39
Drysdale & Co., Ltd. 112

Eagle & Wrights (Gauges), Ltd. 68
Eclipse Foundry & Engineering Co. (Dudley), Ltd. 15
Electrical Power Engineering Co. (B'ham), Ltd. 113
Ellison, G., Ltd. 35
English Abrasives Corporation, Ltd. 108

PAGE

English Numbering Machines, Ltd. 82
Evans, F. W., Ltd. 108
Ewart Chainbelt Co., Ltd. 118
Eyre Smelting Co., Ltd. 153

Farmer, L., & Sons. 151
Farrar Boilerworks, Ltd. 61
Fase Manufacturing Co., Ltd. 56
Ferodo, Ltd. 8
Firth Brown Tools, Ltd. 34
Foord, J., & Co. 151
Ford Motor Co., Ltd. 50-87
Foyles 131
Fuller, Horsey, Sons & Cassell 151

General Descaling Co., Ltd. 62
General Electric Co., Ltd. 53
Gibbons Bros., Ltd. 139
Gibson, J., & Son, Ltd. 126
Gilbarco, Ltd. 27
Gloucester Foundry, Ltd. 54
Goodwin, R., & Sons (Engineers), Ltd. 85
Govan Shafting & Engineering Co. 53
Grafton Cranes, Ltd. 55
Greening, N., & Sons, Ltd. 121
Greenwood & Batley, Ltd. 107
Greenwood's Standard Gear Cutting Co., Ltd. 132
Guest, Keen Iron & Steel Co., Ltd. 58

Hall Bros. (West Bromwich), Ltd. 122
Hall & Hall, Ltd. 125
Hall, J. & E., Ltd. 60
Harland Engineering Co., Ltd. 144
Harlow, R., & Son, Ltd. 123
Harvey & Longstaffe, Ltd. 121
Harvey, G. A., & Co. (London), Ltd. 102
Harvey Ironworks, Ltd. 97
Heatrae, Ltd. 87
Hillside Foundry & Engineering Co. (Cupar), Ltd. 25
Hoffmann Manufacturing Co., Ltd. Cover iii
Holmes, W. C., & Co., Ltd. 90
Holroyd, J., & Co., Ltd. 96
Horne Engineering Co., Ltd. 53
Horsley Group. 142
Hot Dip Galvanizers' Association 124
Howden, J., & Co., Ltd. Cover iv
Hunt Bros. (Oldbury), Ltd. 88

Ilford, Ltd. 10
Impregnated Diamond Products, Ltd. 128

PAGE

Ince Forge Co., Ltd. 41
International Combustion, Ltd. 12
International Computers & Tabulators, Ltd. 14

Jones, Lang, Wootton & Sons 2

Kautex, Ltd. Cover iii
Kempe's Engineers Year-Book 82-147
Kidde, W., Co., Ltd. 142
Kieserling, Th., & Albrecht 21
King, Geo. W., Ltd. 4
Kirk & Co. (Tubes), Ltd. 129
Knight, Frank & Rutley 151

Lafarge Aluminous Cement Co., Ltd. 75
Lamson Engineering Co., Ltd. 67
Lane, G., & Sons, Ltd. 3
Lang Pneumatic, Ltd. 100
Ledward & Beckett, Ltd. 77
Lee & Wilkes, Ltd. 59
Ley's Malleable Castings Co., Ltd. 22
Loveridge, Ltd. 18

McNeil, C., Ltd. 131
Main, A. & J., & Co., Ltd. 98
Mancuna Engineering, Ltd. 77
Mann Egerton & Co., Ltd. 38
Marley, W. H., & Co., Ltd. 79
Marshall Fleming & Co., Ltd. 79
Mason, E. N., & Sons, Ltd. 42
Mather & Platt, Ltd. 114
Mavor & Coulson, Ltd. 69
Mercedes-Benz 11
Mercer, T., Ltd. 28
Metropolitan - Cammell Carriage & Wagon Co., Ltd. 6
Michell Bearings, Ltd. 72
Midland Electric Manufacturing Co., Ltd. 56
Mills, J., Exors. of, Ltd. 143
Mirrlees Watson Co., Ltd. 16
Mole, S., & Sons (Green Lane Foundry), Ltd. 110
Mond Nickel Co., Ltd. 74
Mountford, J., & Co., Ltd. 152
Munro, R. W., Ltd. 132
Murex Welding Processes, Ltd. 19

Neal, R. H., & Co., Ltd. 63
Newall, A. P., & Co., Ltd. 16
Newalls Insulation Co., Ltd. 17
Newton Chambers & Co., Ltd. 36-37
Newton Victor, Ltd. 23
Niagara Screens (Great Britain), Ltd. 110

PAGE

Norris Bros., Ltd. 88
Norton, Sir J. Farmer & Co., Ltd. 5

Oakey, J., & Sons, Ltd. 51
Opperman Gears, Ltd. 91
Osborn, S., & Co., Ltd. 94

Parsons, C. A., & Co., Ltd. 43
Paterson Engineering Co., Ltd. 74
Payne & Griffiths, Ltd. 6
Peglers, Ltd. 70
Phillips, J. W. & C. J., Ltd. 68
Pinchin, Johnson & Co. 59
Pitman, Sir Isaac, & Sons, Ltd. 147
Platt Malleable Castings, Ltd. 53
Pollard, F., & Co., Ltd. 39
Potter, F. W., & Soar, Ltd. 126
Pratt Bros. (Stourbridge), Ltd. 97
Press and Shear Machinery Co., Ltd. 125
Priest Furnaces, Ltd. 95

Quasi-Arc, Ltd. 117

R.A.C. Group. 18
Ransome & Marles Bearing Co., Ltd. 66
Ransomes & Rapier, Ltd. Cover i
Rayner, P., Ltd. 6
Reavell & Co., Ltd. 48
Reed Crane & Hoist Co., Ltd. 133
Reining, Heinrich, G.m.b.H. 124
Renold Chains, Ltd. 65
Renshaw Foundry, Ltd. 25
Research Engineers, Ltd. 61
Reyrolle, A., & Co., Ltd. 138
Richards & Partners. 151
Richmond Welding Co. 61
Riley, A. J., & Son, Ltd. 128
Rivlink Belts, Ltd. 28
Roberts, J. W., Ltd. 26
Robertson & Ferguson, Ltd. 5
Robinson, L., & Co. (Gillingham), Ltd. 55
Robson, G., & Co. (Conveyors), Ltd. 85
Rockwell Machine Tool Co., Ltd. 41
Rotherham & Sons, Ltd. 28

S.M. Precision Spinning Co., Ltd. 113
S.W.F. 48
St. Georges Engineers, Ltd. 50
Sale, H. B., Ltd. 26
Salter, G., & Co., Ltd. Cover ii
Saunders Valve Co., Ltd. 82
Schieldrop & Co., Ltd. 41
Schiess A.G. 31

PAGE

Scottish Machine Tool Corporation, Ltd. 25
Simmonds Aerocessories, Ltd. 30
Simplifix Couplings, Ltd. 7
Sinex Engineering Co., Ltd. 132
Skerne Works, Ltd. 56
Slick Brands, Ltd. 123
Slingsby, W., & Co., Ltd. 150
Smedley Bros., Ltd. 41
Smith & Grace, Ltd. 108
Smith, J. (Keighley), Ltd. 120
Smith, S., & Sons (England), Ltd. 46
Steel Company of Scotland, Ltd. 38
Steel Company of Wales, Ltd. 84
Sturtevant Engineering Co., Ltd. 111
Sulzer Bros. (London), Ltd. 130
Sunbeam Anti-Corrosives, Ltd. 17
Super Oil Seals & Gaskets, Ltd. 97
Sutcliffe, R., Ltd. 116

Tangyes, Ltd. 73-124
Taylor & Hubbard, Ltd. 59
Taylor Industrial Clutches. 26
Taylor Woodrow. 40
Thermal Syndicate, Ltd. 125
Thomas, R., & Baldwins, Ltd. 115
Tilghman's, Ltd. 101
Trinity Pumps, Ltd. 104
Turner Bros. Asbestos Co., Ltd. 88

Unbrako Socket Screw Co., Ltd. 72
United Flexible Metallic Tubing Co., Ltd. 81

Vokes, Ltd. 89

Wailes Dove Bitumastic, Ltd. 20
Ward, T. W., Ltd. 150
Wellman Bibby Co., Ltd. 70
Wellman Smith Owen Engineering Corporation, Ltd. 39
Wells, A. C., & Co., Ltd. 72
West Yorkshire Foundries, Ltd. 80
Westinghouse Brake & Signal Co., Ltd. 80
Westwood, J., & Co., Ltd. 113
Wheatley, Kirk, Price & Co. 151
Widnes Foundry & Engineering Co., Ltd. 29
Wiggin, H., & Co., Ltd. 27
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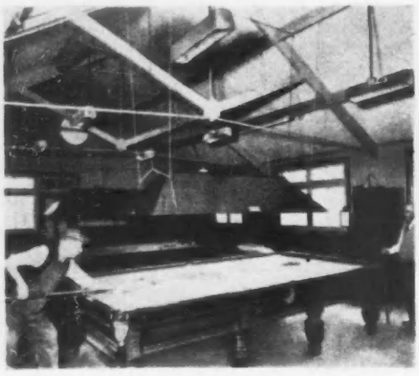

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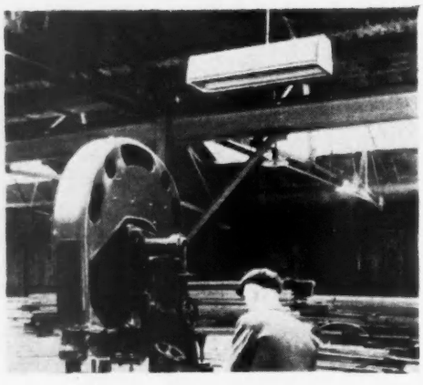

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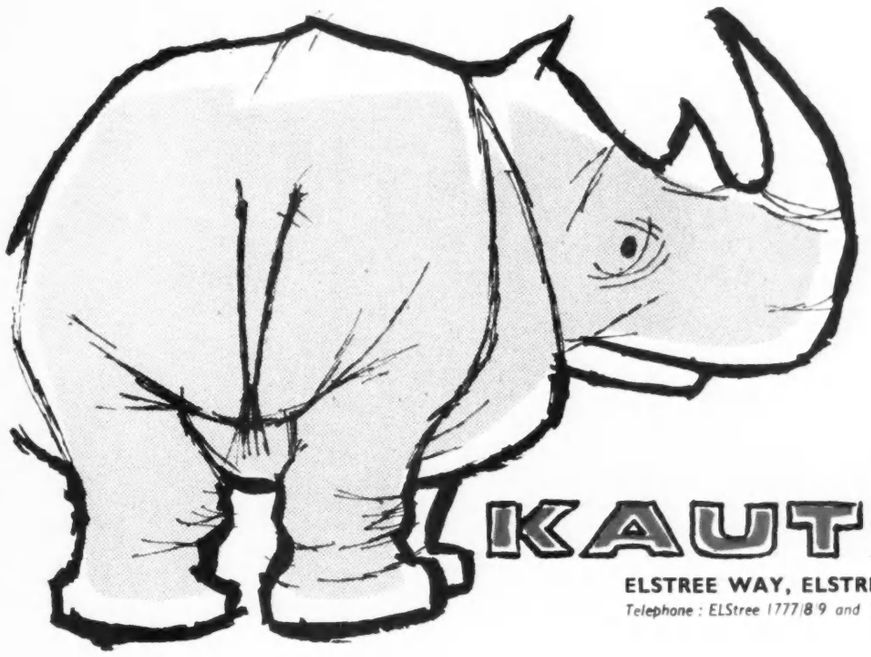

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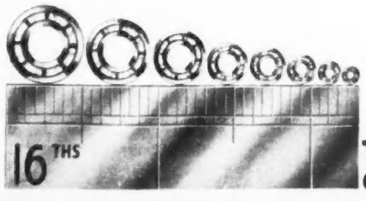

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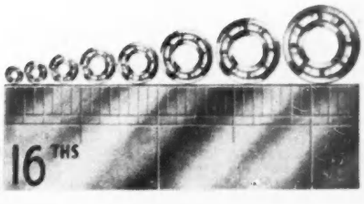

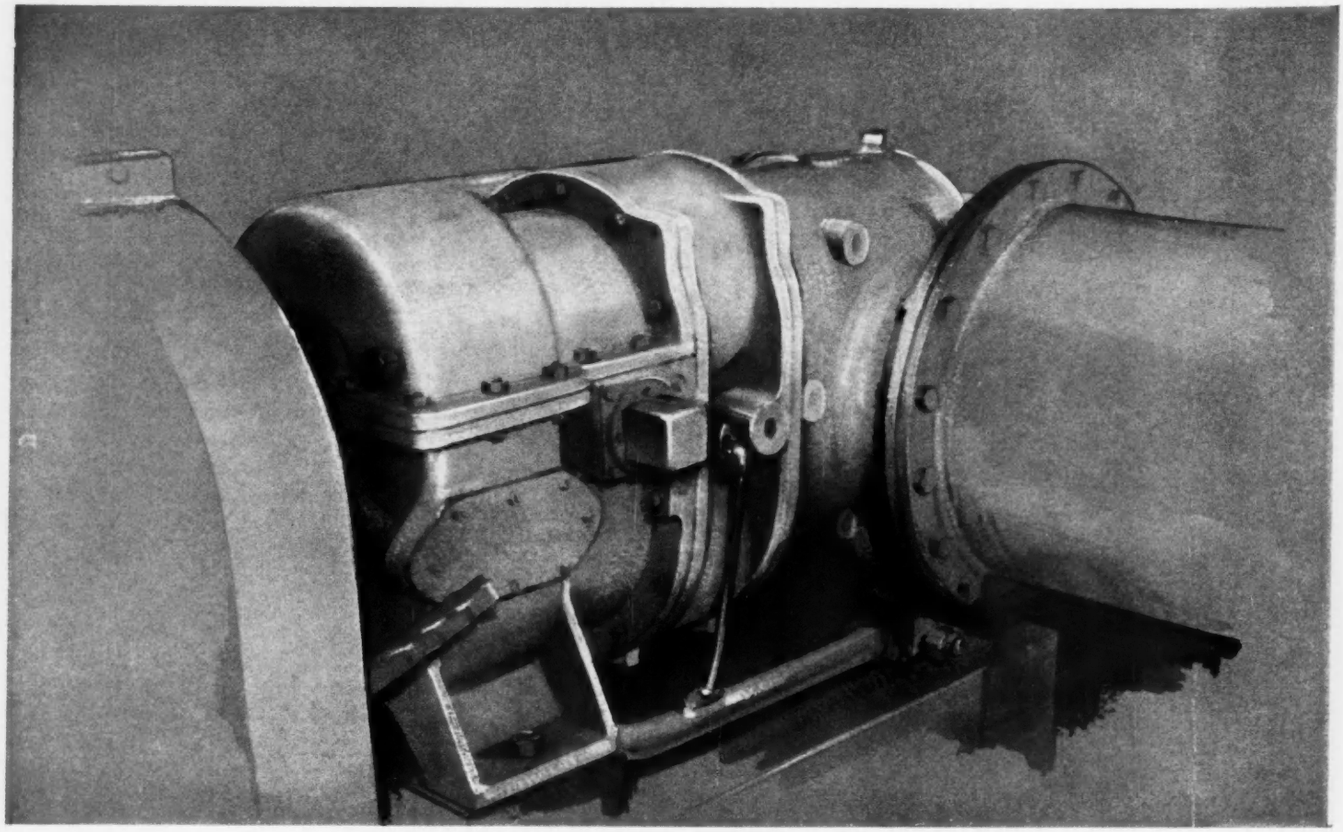

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